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CHAPTER 01
The Living World

2026 (RE-NEET)

1. Arrange the taxonomic categories in ascending order:
(a) Genus,
(b) Class,
(c) Order,
(d) Phylum,
(e) Family,
(f) Kingdom,
(g) Species.
Choose the correct answer from the options given below:
(1) (g), (c), (a), (b), (e), (a), (f)
(2) (f), (c), (b), (g), (d), (e), (a)
(3) (g), (a), (e), (c), (b), (d), (f)
(4) (a), (c), (d), (g), (f), (b), (e)

2026 (RE-NEET)

2. Match List-I with List-II (Mango):
List-I
A. Family;
B. Genus;
C. Class;
D. Phylum;
E. Order.
List-II
I. Sapindales,
II. Dicotyledonae,
III. Anacardiaceae,
IV. Angiospermae,
V. Mangifera
Choose the correct answer from the options given below:
(1) A-III, B-III, C-V, D-I, E-IV
(2) A-III, B-V, C-II, D-IV, E-I
(3) A-I, B-V, C-II, D-IV, E-III
(4) A-II, B-I, C-III, D-IV, E-V

2026 (RE-NEET)

3. Genus represents _____.
(1) a group of closely related species
(2) a group of closely related families
(3) an individual plant or animal
(4) a population of plants and animals

2026 (CANCELLED)

4. Which one of the following statements is NOT true about the universal rules of binomial nomenclature?
(1) Biological names are generally in Latin.
(2) Both the words in a biological name, when handwritten, are separately underlined or printed in italics.
(3) The specific epithet in the biological name starts with a small letter.
(4) The first word in the biological name represents the specific epithet, while the second component denotes the genus.

Manipur NEET 2023

5. 'X' and 'Y' are the components of Binomial nomenclature. This naming system was proposed by 'Z'.
(1) X-Generic name, Y-Specific epithet, Z-Carolus Linnaeus
(2) X-Specific epithet, Y-Generic name, Z-R.H. Whittaker
(3) X-Specific epithet, Y-Generic name, Z-Carolus Linnaeus
(4) X-Generic name, Y-Specific epithet, Z-R.H. Whittaker

Manipur NEET 2023

6. House fly belongs to _____ Family.
(1) Cyprinidae
(2) Hominidae
(3) Calliphoridae
(4) Muscidae

2022

7. In the taxonomic categories which hierarchial arrangement in ascending order is correct in case of animals ?
(1) Kingdom, Phylum, Class, Order, Family, Genus, Species
(2) Kingdom, Class, Phylum, Family, Order, Genus, Species
(3) Kingdom, Order, Class, Phylum, Family, Genus, Species
(4) Kingdom, Order, Phylum, Class, Family, Genus, Species

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2021

8. Which one of the following belongs to the Family Muscidae?
(1) House fly
(2) Fire fly
(3) Grasshopper
(4) Cockroach

2019

9. Select the correctly written scientific name of Mango which was first described by Carolus Linnaeus.
(1) Mangifera Indica
(2) Mangifera indica Car. Linn.
(3) Mangifera indica Linn.
(4) Mangifera indica

Odisha NEET 2019

10. Which of the following is against the rules of ICBN?
(1) Hand written scientific names should be underlined.
(2) Every species should have a generic name and a specific epithet.
(3) Scientific names are in Latin and should be italicized.
(4) Generic and specific names should be written starting with small letters.

NEET-I 2016

11. Nomenclature is governed by certain universal rules. Which one of the following is contrary to the rules of nomenclature?
(1) The names are written in Latin and are italicised.
(2) When written by hand the names are to be underlined.
(3) Biological names can be written in any language.
(4) The first word in a biological name represents the genus name and the second is a specific epithet.

NEET-II 2016

12. Match column I with column II for housefly classification and select the correct option using the codes given below.

	Column I		Column II
A.	Family	(i)	Diptera
B.	Order	(ii)	Arthropoda
C.	Class	(iii)	Muscidae
D.	Phylum	(iv)	Insecta

(1) A-(iii), B-(i), C-(iv), D-(ii)
(2) A-(iii), B-(ii), C-(iv), D-(i)
(3) A-(iv), B-(iii), C-(ii), D-(i)
(4) A-(iv), B-(ii), C-(i), D-(iii)

NEET-II 2016

13. Study the four statements (A-D) given below and select the two correct ones out of them.
A. Definition of biological species was given by Ernst Mayr.
B. Photoperiod does not affect reproduction in plants.
C. Binomial nomenclature system was given by R.H. Whittaker.
D. In unicellular organisms, reproduction is synonymous with growth.
The two correct statements are
(1) B and C
(2) C and D
(3) A and D
(4) A and B.

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Karnataka NEET 2013

14. The common characteristics between tomato and potato will be maximum at the level of their
(1) family
(2) order
(3) division
(4) genus.

Mains 2012

15. Which one of the following organisms is scientifically correctly named, correctly printed according to the International Rules of Nomenclature and correctly described?
(1) Musca domestica - the common house lizard, a reptile
(2) Plasmodium falciparum - a protozoan pathogen causing the most serious type of malaria.
(3) Felis tigris - the Indian tiger, well protected in Gir forests.
(4) E.coli - full name Entamoeba coli, a commonly occurring bacterium in human intestine.

Mains 2011

16. Which one of the following aspects is an exclusive characteristic of living things?
(1) Isolated metabolic reactions occur in vitro.
(2) Increase in mass from inside only.
(3) Perception of events happening in the environment and their memory.
(4) Increase in mass by accumulation of material both on surface as well as internally.

2011

17. Which one of the following animals is correctly matched with its particular taxonomic category?
(1) Tiger - tigris, species
(2) Cuttlefish - mollusca, class
(3) Humans - primata, family
(4) Housefly - Musca, order

2007

18. The living organisms can be unexceptionally distinguished from the non-living things on the basis of their ability for
(1) interaction with the environment and progressive evolution
(2) reproduction
(3) growth and movement
(4) responsiveness to touch.

2007

19. Biological organisation starts with
(1) cellular level
(2) organismic level
(3) atomic level
(4) submicroscopic molecular level.

2007

20. ICBN stands for
(1) International Code of Botanical Nomenclature
(2) International Congress of Biological Names
(3) Indian Code of Botanical Nomenclature
(4) Indian Congress of Biological Names.

2003

21. Biosystematics aims at
(1) the classification of organisms based on broad morphological characters
(2) delimiting various taxa of organisms and establishing their relationships
(3) the classification of organisms based on their evolutionary history and establishing their phylogeny on the totality of various parameters from all fields of studies
(4) identification and arrangement of organisms on the basis of their cytological characteristics.

2003

22. Species are considered as
(1) real basic units of classification
(2) the lowest units of classification
(3) artificial concept of human mind which cannot be defined in absolute terms
(4) real units of classification devised by taxonomists.

2001

23. Which of the following is less general in characters as compared to genus?
(1) Species
(2) Division
(3) Class
(4) Family

1999

24. The book 'Genera Plantarum' was written by
(1) Engler and Prantl
(2) Bentham and Hooker
(3) Bessey
(4) Hutchinson.

1996

25. 'Taxon' is the unit of a group of
(1) order
(2) taxonomy
(3) species
(4) genes.

1993

26. Linnaeus is credited with
(1) binomial nomenclature
(2) theory of biogenesis
(3) discovery of microscope
(4) discovery of blood circulation.

1992

27. Sequence of taxonomic categories is
(1) class-phylum-tribe-order-family-genus-species
(2) division-class-family-tribe-order-genus-species
(3) division-class-order-family-tribe-genus-species.
(4) phylum-order-class-tribe-family-genus-species.

1992

28. The term phylum was given by
(1) Cuvier
(2) Haeckel
(3) Theophrastus
(4) Linnaeus.

1992, 1991

29. A group of plants or animals with similar traits of any rank is
(1) species
(2) genus
(3) order
(4) taxon.

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1992, 1990

30. A taxon is
(1) a group of related families
(2) a group of related species
(3) a type of living organisms
(4) a taxonomic group of any ranking.

1990

31. Linnaeus evolved a system of nomenclature called
(1) mononomial
(2) vernacular
(3) binomial
(4) polynomial.

1990

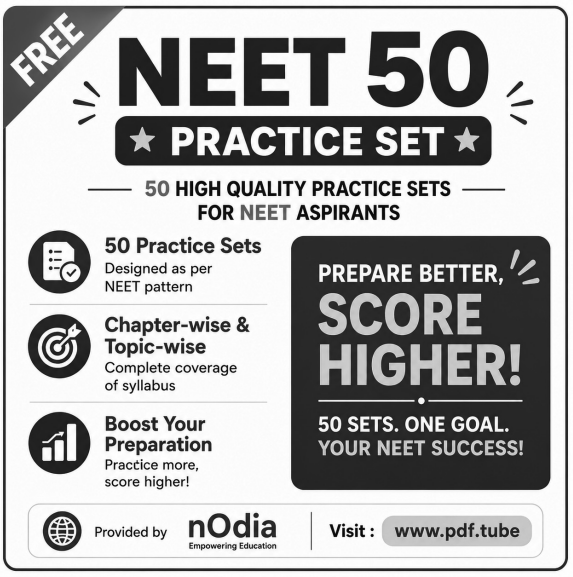
32. Basic unit or smallest taxon of taxonomy/ classification is
(1) species
(2) kingdom
(3) family
(4) variety.

1988

33. The term "New Systematics" was introduced by
(1) Bentham and Hooker
(2) Linnaeus
(3) Julian Huxley
(4) A.P. de Candolle.

1988

34. Static concept of species was put forward by
(1) de Candolle
(2) Linnaeus
(3) Theophrastus
(4) Darwin.



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ANSWERS

1. (3) (g), (a), (e), (c), (b), (d), (f)
In ascending order the hierarchy is species, genus, family, order, class, phylum and kingdom. This corresponds to (g), (a), (e), (c), (b), (d), (f), where species is lowest and kingdom is highest.

2. (2) A-III, B-V, C-II, D-IV, E-I
For mango: family Anacardiaceae (III), genus Mangifera (V), class Dicotyledonae (II), phylum Angiospermae (IV), order Sapindales (I). This gives A-III, B-V, C-II, D-IV, E-I.

3. (1) a group of closely related species
A genus is a taxonomic category comprising a group of closely related species sharing common characters. For example, the genus Panthera includes lion, tiger and leopard. Thus genus represents an assemblage of related species.

4. (4) The first word in the biological name represents the specific epithet, while the second component denotes the genus.
In binomial nomenclature the first word represents the genus, and the second word denotes the specific epithet, not the reverse. Hence statement (4) is incorrect. The other rules about Latin names, italics/underlining, and a small-letter specific epithet are all correctly stated.

5. (1) X-Generic name, Y-Specific epithet, Z-Carolus Linnaeus
Binomial nomenclature is a standardized system for naming living organisms with two distinct parts. The first part represents the genus name, while the second part identifies the specific epithet. This scientific method was formally introduced by Carolus Linnaeus. It ensures that every organism has a unique, universally recognized name to avoid confusion across various different regions and languages.

6. (4) Muscidae
The common housefly, known scientifically as Musca domestica, belongs to the family Muscidae. Within the taxonomic hierarchy, this family is part of the order Diptera, which includes all true flies. Members of Muscidae are found worldwide and are significant due to their role as vectors for various diseases. Systematic classification helps in identifying and studying these insects accurately.

7. (1) Kingdom, Phylum, Class, Order, Family, Genus, Species
Taxonomic categories are organized in a structured hierarchy to classify organisms systematically. The sequence typically followed involves major levels such as kingdom, phylum, class, order, family, genus, and finally species. This framework allows scientists to group animals based on shared characteristics and evolutionary relationships. While kingdom is the most inclusive category, species represents the most specific and fundamental unit.

8. (1) House fly
The housefly is a common insect that is classified under the family Muscidae. This family belongs to the order Diptera, characterized by having a single pair of wings. Muscidae includes various species that are often associated with human habitations. Systematic classification relies on morphological and biological traits to group organisms into specific families like Muscidae for accurate identification.

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9. (3) Mangifera indica Linn.
The scientific name of mango is written as Mangifera indica Linn. following the rules of binomial nomenclature. Mangifera represents the genus, while indica is the specific epithet. The abbreviation Linn. indicates that Carolus Linnaeus was the first scientist to describe this species. Names must be in Latin, with the genus capitalized and the specific epithet written in lowercase.

10. (4) Generic and specific names should be written starting with small letters.
The International Code of Botanical Nomenclature establishes strict rules for naming plants. According to these regulations, the generic name must always start with a capital letter, while the specific epithet should begin with a small letter. Scientific names are typically derived from Latin and are italicized when printed. If handwritten, the two components

must be underlined separately to distinguish them.

11. (3) Biological names can be written in any language.
Universal rules of nomenclature dictate that biological names must be in Latin or latinized, regardless of their origin. They are traditionally printed in italics or underlined when handwritten. A name consists of two parts: the genus name starting with a capital letter and the specific epithet starting with a small letter. Writing names in any language is not permitted.

12. (1) A-(iii), B-(i), C-(iv), D-(ii)
The housefly, Musca domestica, is classified within several hierarchical levels. It belongs to the family Muscidae and the order Diptera. Furthermore, it is placed in the class Insecta due to its three pairs of legs and other anatomical features. Finally, it falls under the phylum Arthropoda, which encompasses organisms with jointed appendages and a chitinous exoskeleton. This classification ensures consistency.

13. (3) A and D
Ernst Mayr is renowned for providing the biological concept of species based on reproductive isolation. In unicellular organisms like bacteria or amoeba, reproduction is effectively synonymous with growth because cell division results in an increase in the number of individuals. However, photoperiod does significantly affect reproduction in many plants, and the binomial nomenclature system was actually proposed by Carolus Linnaeus.

14. (1) family
Both tomato and potato belong to the same family, Solanaceae. In the taxonomic hierarchy, as we move from species to kingdom, the number of common characteristics generally decreases. Therefore, tomato and potato share more similarities at the family level than at higher levels like order. Their inclusion in Solanaceae is based on shared floral and vegetative traits among plants.

15. (2) Plasmodium falciparum - a protozoan pathogen causing the most serious type of malaria.
Plasmodium falciparum is a protozoan parasite responsible for causing malignant tertian malaria, which is the most severe form of the disease. The name follows binomial nomenclature rules with a capitalized genus and lowercase specific epithet. Other organisms often have errors in their descriptions, such as Musca domestica being an insect, not a lizard, and Panthera tigris referring correctly to tigers.

16. (3) Perception of events happening in the environment and their memory.
Consciousness, or the ability to perceive and respond to environmental stimuli, is a defining and exclusive property of living organisms. Non-living things do not possess the biological mechanisms required to sense surroundings or process information. Consciousness involves a complex interaction with external factors that is unique to all life forms, ranging from simple prokaryotes to complex multicellular humans.

17. (1) Tiger - tigris, species
In the scientific name Panthera tigris, the word tigris represents the specific epithet, which identifies the species. Classification involves assigning organisms to specific ranks such as genus or family. For instance, humans belong to the order Primates and the family Hominidae. Houseflies are in the genus Musca and the order Diptera. Correct matching requires understanding the specific hierarchical level assigned.

18. (4) responsiveness to touch.
Living organisms are uniquely characterized by their ability to sense their surroundings and respond to environmental stimuli, such as touch, light, or temperature. This responsiveness, known as irritability or consciousness, is a fundamental trait of all life forms. While non-living objects may show increase in mass through external accumulation, they lack the intrinsic biological capacity to react to changes.

19. (4) submicroscopic molecular level.
Biological organization is a complex hierarchy that begins at the submicroscopic molecular level. It involves the arrangement of various inorganic and organic molecules, such as proteins, lipids, and nucleic acids, which eventually form organelles and cells. Although the cell is the basic unit of life, the foundation of living systems lies in these molecular interactions that sustain all processes.

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20. (1) International Code of Botanical Nomenclature
ICBN stands for the International Code of Botanical Nomenclature, which provides the set of rules and recommendations for the formal scientific naming of plants. Its primary purpose is to ensure that each plant group has only one correct name that is recognized globally. This standardization prevents confusion and facilitates clear communication among scientists and researchers working in plant biology.

21. (3) the classification of organisms based on their evolutionary history and establishing their phylogeny on the totality of various parameters from all fields of studies
Biosystematics is a comprehensive field that aims to classify organisms based on their evolutionary history and phylogenetic relationships. It integrates data from various disciplines, including morphology, genetics, ecology, and biochemistry, to establish a holistic understanding of how species are related. By considering the totality of these parameters, biosystematics provides a more accurate reflection of the natural world and pathways.

22. (1) real basic units of classification
Species are considered the real basic units of biological classification. They represent a group of individuals that share common morphological and physiological characteristics and are capable of interbreeding to produce fertile offspring. As the most fundamental level in the taxonomic hierarchy, species provide the framework for understanding biological diversity and evolutionary relationships. They are distinct, natural entities rather than constructs.

23. (1) Species
In the taxonomic hierarchy, species is the category that is less general and more specific compared to genus. As we move down the hierarchy from kingdom to species, the organisms share a greater number of common characteristics and become more similar. Therefore, species members are more closely related to each other than members of a genus, family, or class.

24. (2) Bentham and Hooker
The monumental work 'Genera Plantarum' was authored by George Bentham and Joseph Dalton Hooker. This three-volume publication describes a comprehensive system of plant classification based on natural characteristics. It provides detailed descriptions of all known genera of seed plants at that time. This system remains influential in many herbaria worldwide for organizing plant specimens and understanding the plant kingdom.

25. (2) taxonomy
A taxon is a fundamental unit used in the field of taxonomy to represent a group of organisms at any level of the biological hierarchy. It can refer to a species, genus, family, order, class, phylum, or kingdom. Each taxon is a group of real organisms categorized based on shared traits. Taxonomy uses these units to organize life.

26. (1) binomial nomenclature
Carolus Linnaeus is famously credited with the development and popularization of the binomial nomenclature system. This method assigns a two-part scientific name to every organism, consisting of the genus name and the specific epithet. This revolutionary approach brought order to the naming process, replacing long, descriptive names with a concise and universal format. It remains the global standard today.

27. (3) division-class-order-family-tribe-genus-species.
The correct hierarchical sequence of taxonomic categories from higher to lower levels is division, class, order, family, tribe, genus, and species. In plant classification, division is used instead of phylum. Each level represents a group of organisms sharing common characteristics, with the level of similarity increasing as we move toward species. This structure helps scientists categorize the vast diversity.

28. (2) Haeckel
The term 'phylum' was introduced by Ernst Haeckel to describe a major taxonomic group in animal classification. It ranks below kingdom and above class. This term is used to group organisms that share a basic body plan and structural organization. While the term 'division' is typically used for plants, 'phylum' remains the standard designation for primary subdivisions of animals.

29. (4) taxon.
A taxon is defined as a group of plants or animals that share similar traits and belong to any rank in the taxonomic hierarchy. Whether it is a species, family, or class, each level is considered a

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taxon. This term provides a general way to refer to any group without specifying its exact rank. Taxa help in organizing biological diversity.

30. (4) a taxonomic group of any ranking.
A taxon represents a group of organisms classified together based on shared characteristics at any level of the biological hierarchy. It is a flexible term that can apply to a kingdom, phylum, class, order, family, genus, or species. By using the concept of a taxon, scientists can categorize and discuss different groups of life forms systematically within taxonomy.

31. (3) binomial
Carolus Linnaeus developed the binomial system of nomenclature, which is the standard method for naming species. Each name consists of two parts: the genus name and the specific epithet. This system replaced cumbersome polynomial names and provided a universal language for scientists worldwide. By using binomials, researchers can identify organisms precisely, ensuring that each species has a unique recognized name.

32. (1) species
The species is the basic and smallest unit of biological classification. It consists of a group of organisms that are morphologically similar and capable of interbreeding to produce fertile offspring in nature. In the taxonomic hierarchy, species represent the most specific level, serving as the foundation upon which larger groups like genera, families, and orders are built to categorize life.

33. (3) Julian Huxley
The term 'New Systematics' was introduced by Julian Huxley in 1940. This approach, also known as biosystematics, emphasized the importance of evolutionary relationships, genetics, and ecology in the classification of organisms. Unlike classical taxonomy, which focused primarily on morphological traits, New Systematics considers a wider range of biological evidence to understand the complex variations and relationships within species.

34. (2) Linnaeus
The static concept of species was proposed by Carolus Linnaeus, who believed that species were fixed and unchanging entities created by a divine power. According to this view, the characteristics of a species remained constant over time, with no possibility of evolutionary change or transformation. This idea stood in contrast to later dynamic concepts, such as those introduced by Darwin.

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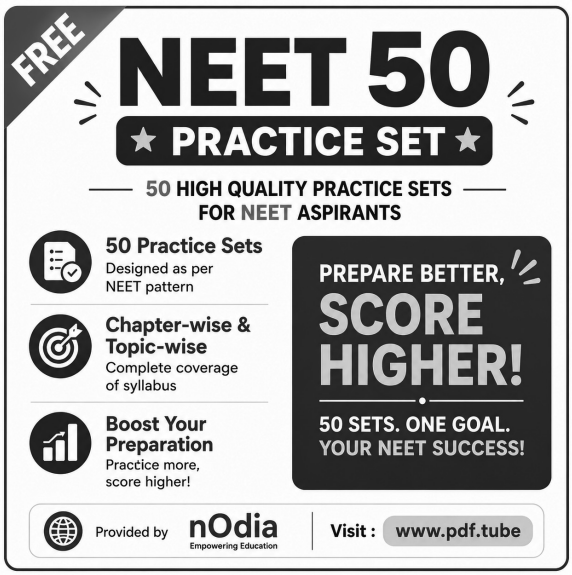

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CHAPTER 02
Biological Classification

2026 (RE-NEET)

1. Match List-I with List-II:
A. Fusion of protoplasms between gametes;
B. Fusion of two nuclei;
C. Generation of haploid spores.
I. Meiosis,
II. Plasmogamy,
III. Karyogamy)
(1) A-III, B-II, C-I
(2) A-I, B-III, C-II
(3) A-II, B-III, C-I
(4) A-II, B-I, C-III

2026 (RE-NEET)

2. Mad cow disease is caused by:
(1) Aspergillus sp.
(2) Mycoplasma sp.
(3) prions
(4) viroids

2026 (RE-NEET)

3. Match List-I with List-II:
List-I
A. Spherical;
B. Rod;
C. Comma;
D. Spirillum.
List-II
I. Vibrio,
II. Cocci,
III. Spirilla,
IV. Bacilli
(1) A-II, B-I, C-IV, D-III
(2) A-II, B-IV, C-I, D-III
(3) A-I, B-III, C-II, D-IV
(4) A-III, B-II, C-I, D-IV

2026 (RE-NEET)

4. Which of the following is not a prokaryote?
(1) Mycoplasma
(2) Fungi
(3) Bacteria
(4) Blue green algae

2026 (RE-NEET)

5. Symbiotic association between fungi and algae are called _____.
(1) mycorrhiza
(2) chrysophytes
(3) lichens
(4) sponges

2026 (CANCELLED)

6. The main criteria used for Five Kingdom Classification proposed by R.H. Whittaker (1969) included:
A. Cell structure
B. Body organization
C. Presence of flagellum
D. Reproduction
E. Phylogenetic relationships
(1) A, B, C, D and E
(2) B, C and D only
(3) A, B, D and E only
(4) A, B and E only

2025

7. Each of the following characteristics represent a Kingdom proposed by Whittaker. Arrange the following in increasing order of complexity of body organization.
A. Multicellular heterotrophs with cell wall made of chitin.
B. Heterotrophs with tissue/organ/organ system level of body organization.
C. Prokaryotes with cell wall made of polysaccharides and amino acids.
D. Eukaryotic autotrophs with tissue/organ level of body organization.
E. Eukaryotes with cellular body organization.
Choose the correct answer from the options given below:
(1) A, C, E, D, B
(2) C, E, A, B, D
(3) A, C, E, B, D
(4) C, E, A, D, B

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RE-EXAM 2024

8. Match List- I with List-II.

List-I (Organisms)		List-II (Mode of Nutrition)	
A.	Euglenoid	I.	Parasitic
B.	Dinoflagellate	II.	Saprophytic

C.	Slime mould	III.	Photosynthetic
D.	Plasmodium	IV.	Switching between photosynthetic and heterotrophic mode

Choose the correct answer from the options given below.
(1) A-III, B-IV, C-II, D-I
(2) A-IV, B-II, C-I, D-III
(3) A-IV, B-III, C-II, D-I
(4) A-IV, B-II, C-III, D-I

2024

9. Match List I with List II.

List I (Fungi)		List II (Common Names/Types)	
A.	Rhizopus	I.	Mushroom
B.	Ustilago	II.	Smut fungus
C.	Puccinia	III.	Bread mould
D.	Agaricus	IV.	Rust fungus

Choose the correct answer from the options given below.
(1) A-III, B-II, C-IV, D-I
(2) A-I, B-III, C-II, D-IV
(3) A-III, B-II, C-I, D-IV
(4) A-IV, B-III, C-II, D-I

2024

10. Which one of the following is not a criterion for classification of fungi?
(1) Morphology of mycelium
(2) Mode of nutrition
(3) Mode of spore formation
(4) Fruiting body

2022

11. Given below are two statements:
Statement I : Mycoplasma can pass through less than 1 micron filter size.
Statement II : Mycoplasma are bacteria with cell wall.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Both Statement I and Statement II are correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is correct but Statement II is incorrect
(4) Statement I is incorrect but Statement II is correct

2022

12. Which of the following is a correct statement?
(1) Cyanobacteria are a group of autotrophic organisms classified under Kingdom Monera.
(2) Bacteria are exclusively heterotrophic organisms.
(3) Slime moulds are saprophytic organisms classified under Kingdom Monera.
(4) Mycoplasma have DNA, Ribosome and cell wall.

2021

13. Which of the following statements is correct?
(1) Some of the organisms can fix atmospheric nitrogen in specialised cells called sheath cells.
(2) Fusion of two cells is called karyogamy.
(3) Fusion of protoplasms between two motile or non-motile gametes is called plasmogamy.
(4) Organisms that depend on living plants are called saprophytes.

2020

14. Which of the following is correct about viroids?
(1) They have RNA with protein coat.
(2) They have free RNA without protein coat.
(3) They have DNA with protein coat.
(4) They have free DNA without protein coat.

Odisha NEET 2019

15. Match the organisms in column-I with habitats in column-II.

	Column-I		Column-II
A.	Halophiles	(i)	Hot springs
B.	Thermoacido-philes	(ii)	Aquatic environment
C.	Methanogens	(iii)	Guts of ruminants
D.	Cyanobacteria	(iv)	Salty area

Select the correct answer from the options given below.
(1) A-(iv), B-(i), C-(iii), D-(ii)
(2) A-(i), B-(ii), C-(iii), D-(iv)
(3) A-(iii), B-(iv), C-(ii), D-(i)
(4) A-(ii), B-(iv), C-(iii), D-(i)

2019

16. Which of the following statements is incorrect?
(1) Yeasts have filamentous bodies with long thread like hyphae.
(2) Morels and truffles are edible delicacies.
(3) Claviceps is a source of many alkaloids and LSD.
(4) Conidia are produced exogenously and ascospores endogenously.

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2019

17. Match column -I with column - II.

	Column I		Column II
A.	Saprophyte	(i)	Symbiotic association of fungi with plant roots
B.	Parasite	(ii)	Decomposition of dead organic materials
C.	Lichens	(iii)	Living on living plants or animals
D.	Mycorrhiza	(iv)	Symbiotic association of algae and fungi

Choose the correct answer from the options given below.
(1) A-(ii), B-(iii), C-(iv), D-(i)
(2) A-(i), B- (ii), C- (iii), D- (iv)
(3) A-(iii), B- (ii), C- (i), D- (iv)
(4) A-(ii), B- (i), C- (iii), D- (iv)

Odisha NEET 2019

18. Mad cow disease in cattle is caused by an organism which has
(1) inert crystalline structure
(2) abnormally folded protein
(3) free RNA without protein coat
(4) free DNA without protein coat.

2019

19. Which of the following statements is incorrect?
(1) Prions consist of abnormally folded proteins.
(2) Viroids lack a protein coat.
(3) Viruses are obligate parasites.
(4) Infective constituent in viruses is the protein coat.

2018

20. Which of the following organisms are known as chief producers in the oceans?
(1) Dinoflagellates
(2) Diatoms
(3) Cyanobacteria
(4) Euglenoids

2018

21. Ciliates differ from all other protozoans in
(1) using flagella for locomotion
(2) having a contractile vacuole for removing excess water
(3) using pseudopodia for capturing prey
(4) having two types of nuclei.

2018

22. Which among the following is not a prokaryote?
(1) Saccharomyces
(2) Mycobacterium
(3) Nostoc
(4) Oscillatoria

2018

23. After karyogamy followed by meiosis, spores are produced exogenously in
(1) Neurospora
(2) Alternaria
(3) Agaricus
(4) Saccharomyces.

2018

24. Select the wrong statement.
(1) Cell wall is present in members of fungi and plantae.
(2) Mushrooms belong to basidiomycetes.
(3) Pseudopodia are locomotory and feeding structures in sporozoans.
(4) Mitochondria are the powerhouse of the cell in all kingdoms except monera.

2017

25. Which of the following are found in extreme saline conditions?
(1) Eubacteria
(2) Cyanobacteria
(3) Mycobacteria
(4) Archaebacteria

2017

26. Which among the following are the smallest living cells, known without a definite cell wall, pathogenic to plants as well as animals and can survive without oxygen?
(1) Pseudomonas
(2) Mycoplasma
(3) Nostoc
(4) Bacillus

NODIA

2017

27. Which of the following components provides sticky character to the bacterial cell?
(1) Nuclear membrane
(2) Plasma membrane
(3) Glycocalyx
(4) Cell wall

2017

28. DNA replication in bacteria occurs
(1) within nucleolus
(2) prior to fission

(3) just before transcription
(4) during S phase.

2017

29. Viroids differ from viruses in having
(1) DNA molecules without protein coat
(2) RNA molecules with protein coat
(3) RNA molecules without protein coat
(4) DNA molecules with protein coat.

NEET-II 2016

30. Methanogens belong to
(1) eubacteria
(2) archaebacteria
(3) dinoflagellates
(4) slime moulds.

NEET-I 2016

31. The primitive prokaryotes responsible for the production of biogas from the dung of ruminant animals, include the
(1) methanogens
(2) eubacteria
(3) halophiles
(4) thermoacidophiles.

NEET-II 2016

32. Select the wrong statement.
(1) The walls of diatoms are easily destructible.
(2) 'Diatomaceous earth' is formed by the cell walls of diatoms.
(3) Diatoms are chief producers in the oceans.
(4) Diatoms are microscopic and float passively in water.

NEET-I 2016

33. Chrysophytes, Euglenoids, Dinoflagellates and Slime moulds are included in the Kingdom
(1) Fungi (2) Animalia
(3) Monera (4) Protista.

NEET-II 2016

34. Which one of the following is wrong for fungi?
(1) They are eukaryotic.
(2) All fungi possess a purely cellulosic cell wall.
(3) They are heterotrophic.
(4) They are both unicellular and multicellular.

NEET-I 2016

35. Which one of the following statements is wrong?
(1) Eubacteria are also called false bacteria.
(2) Phycomycetes are also called algal fungi.
(3) Cyanobacteria are also called blue-green algae.
(4) Golden algae are also called desmids.

NEET-I 2016

36. One of the major components of cell wall of most fungi is
(1) cellulose
(2) hemicellulose
(3) chitin
(4) peptidoglycan.

NEET-I 2016

37. Which of the following statements is wrong for viroids?
(1) They cause infections.
(2) Their RNA is of high molecular weight.
(3) They lack a protein coat.
(4) They are smaller than viruses.

2015

38. In which group of organisms the cell walls form two thin overlapping shells which fit together?
(1) Dinoflagellates
(2) Slime moulds
(3) Chrysophytes
(4) Euglenoids

NODIA

2015

39. The imperfect fungi which are decomposers of litter and help in mineral cycling belong to
(1) Phycomycetes
(2) Ascomycetes
(3) Deuteromycetes
(4) Basidiomycetes.

2015

40. Choose the wrong statement.
(1) Morels and truffles are poisonous mushrooms.
(2) Yeast is unicellular and useful in fermentation.
(3) Penicillium is multicellular and produces antibiotics.
(4) Neurospora is used in the study of biochemical genetics.

2015 Cancelled

41. Which one of the following matches is correct?
(1) Mucor Reproduction by conjugation Ascomycetes
(2) Agaricus Parasitic fungus Basidiomycetes
(3) Phytophthora Aseptate mycelium Basidiomycetes
(4) Alternaria Sexual reproduction absent Deuteromycetes

2015

42. Cell wall is absent in
(1) Mycoplasma
(2) Nostoc
(3) Aspergillus
(4) Funaria.

2015 Cancelled

43. True nucleus is absent in
(1) Vaucheria
(2) Volvox
(3) Anabaena
(4) Mucor.

2015

44. Pick up the wrong statement.
(1) Some fungi are edible.
(2) Nuclear membrane is present in Monera.
(3) Cell wall is absent in Animalia.
(4) Protists have photosynthetic and heterotrophic modes of nutrition.

2015

45. Select the wrong statement.
(1) The term 'contagium vivum fluidum' was coined by M. W. Beijerinck.
(2) Mosaic disease in tobacco and AIDS in human being are caused by viruses.
(3) The viroids were discovered by D.J. Ivanowsky.
(4) W.M. Stanley showed that viruses could be crystallised.

2014

46. Five kingdom system of classification suggested by R.H. Whittaker is not based on
(1) presence or absence of a well defined nucleus
(2) mode of reproduction
(3) mode of nutrition
(4) complexity of body organisation.

2014

47. Archaebacteria differ from eubacteria in
(1) cell membrane structure
(2) mode of nutrition
(3) cell shape
(4) mode of reproduction.

2014

48. Which one of the following fungi contains hallucinogens?
(1) Morchella esculenta
(2) Amanita muscaria
(3) Neurospora sp.
(4) Ustilago Sp.

2014

49. Which one of the following living organisms completely lacks a cell wall?
(1) Cyanobacteria
(2) Sea-fan (Gorgonia)
(3) Saccharomyces
(4) Blue-green algae

2014

50. Which of the following shows coiled RNA strand and capsomeres?
(1) Polio virus
(2) Tobacco mosaic virus
(3) Measles virus
(4) Retrovirus

2014

51. Viruses have
(1) DNA enclosed in a protein coat
(2) prokaryotic nucleus
(3) single chromosome
(4) both DNA and RNA.

2013

52. Which of the following are likely to be present in deep sea water?
(1) Blue-green algae
(2) Saprophytic fungi
(3) Archaebacteria
(4) Eubacteria

2013

53. Pigment containing membranous extensions in some cyanobacteria are
(1) pneumatophores
(2) chromatophores
(3) heterocysts
(4) basal bodies.

Karnataka NEET 2013

54. Which one of the following is true for fungi?
(1) They lack a rigid cell wall.
(2) They are heterotrophs.
(3) They lack nuclear membrane.
(4) They are phagotrophs.

2012

55. Maximum nutritional diversity is found in the group
(1) fungi (2) animalia
(3) monera (4) plantae.

Mains 2012

56. In the five kingdom classification, Chlamydomonas and Chlorella have been included in
(1) protista (2) algae
(3) plantae (4) monera.

2012

57. The cyanobacteria are also referred to as
(1) protists
(2) golden algae
(3) slime moulds
(4) blue green algae.

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2012

58. The most abundant prokaryotes helpful to humans in making curd from milk and in production of antibiotics are the ones categorised as
(1) cyanobacteria
(2) archaebacteria
(3) chemosynthetic autotrophs
(4) heterotrophic bacteria.

2012

59. Nuclear membrane is absent in
(1) Penicillium
(2) Agaricus
(3) Volvox
(4) Nostoc.

2012

60. Which statement is wrong for viruses?
(1) All are parasites.
(2) All of them have helical symmetry.
(3) They have ability to synthesize nucleic acids and proteins.
(4) Antibiotics have no effect on them.

2012

61. Which one single organism or the pair of organisms is correctly assigned to its or their named taxonomic group?
(1) Paramecium and Plasmodium belong to the same kingdom as that of Penicillium.
(2) Lichen is a composite organism formed from the symbiotic association of an algae and a protozoan.
(3) Yeast used in making bread and beer is a fungus.
(4) Nostoc and Anabaena are examples of Protista.

2011

62. In eubacteria, a cellular component that resembles eukaryotic cell is
(1) plasma membrane
(2) nucleus
(3) ribosomes
(4) cell wall.

2011

63. Which one of the following organisms is not an eukaryote?
(1) Paramecium caudatum
(2) Escherichia coli
(3) Euglena viridis
(4) Amoeba proteus

Mains 2011

64. The pathogen Microsporum responsible for ringworm disease in humans belongs to the same kingdom of organisms as that of
(1) Taenia, a tapeworm
(2) Wuchereria, a filarial worm
(3) Rhizopus, a mould
(4) Ascaris, a round worm.

2010

65. Some hyperthermophilic organisms that grow in highly acidic (pH 2) habitats belong to the two groups
(1) eubacteria and archaea
(2) cyanobacteria and diatoms
(3) protists and mosses
(4) liverworts and yeasts.

Mains 2010

66. Select the correct combination of the statements (i-iv) regarding the characteristics of certain organisms.
(i) Methanogens are archaebacteria which produce methane in marshy areas.
(ii) Nostoc is a filamentous blue-green alga which fixes atmospheric nitrogen.
(iii) Chemosynthetic autotrophic bacteria synthesize cellulose from glucose.
(iv) Mycoplasma lack a cell wall and can survive without oxygen.
The correct statements are
(1) (ii) and (iii)
(2) (i), (ii) and (iii)
(3) (ii), (iii) and (iv)
(4) (i), (ii) and (iv).

2010

67. Single-celled eukaryotes are included in
(1) protista
(2) fungi
(3) archaea
(4) monera.

2010

68. Membrane-bound organelles are absent in
(1) Saccharomyces
(2) Streptococcus
(3) Chlamydomonas
(4) Plasmodium.

Mains 2010

69. Black (stem) rust of wheat is caused by
(1) Alternaria solani
(2) Ustilago nuda
(3) Puccinia graminis
(4) Xanthomonas oryzae.

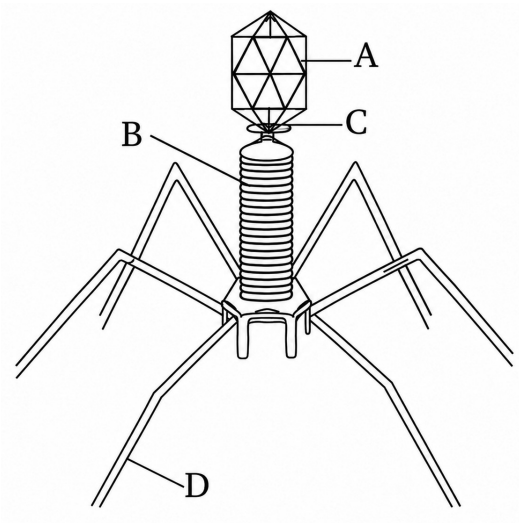
NODIA

2010

70. Virus envelope is known as
(1) capsid
(2) virion
(3) nucleoprotein
(4) core.

Mains 2010

71. Given below is the diagram of a bacteriophage. In which one of the options all the four parts A, B, C and D are correct?



(1) A-Tail fibres, B-Head, C-Sheath, D-Collar
(2) A-Sheath, B-Collar, C-Head, D-Tail fibres
(3) A-Head, B-Sheath, C-Collar, D-Tail fibres
(4) A-Collar, B-Tail fibres, C-Head, D-Sheath

2009

72. Which one is the wrong pairing for the disease and its causal organism?
(1) Black rust of wheat-Puccinia graminis
(2) Loose smut of wheat-Ustilago nuda
(3) Root knot of vegetables-Meloidogyne Sp.
(4) Late blight of potato-Alternaria solani

2009

73. T.O. Diener discovered a
(1) free infectious DNA
(2) infectious protein
(3) bacteriophage
(4) free infectious RNA.

2008

74. Bacterial leaf blight of rice is caused by a species
(1) Alternaria
(2) Erwinia
(3) Xanthomonas
(4) Pseudomonas.

2008

75. Thermococcus, Methanococcus and Methanobacterium exemplify
(1) bacteria whose DNA is relaxed or positively supercoiled but which have a cytoskeleton as well as mitochondria
(2) bacteria that contain a cytoskeleton and ribosomes
(3) archaebacteria that contain protein homologous to eukaryotic core histones
(4) archaebacteria that lack any histones resembling those found in eukaryotes but whose DNA is negatively supercoiled.

2008

76. In the light of recent classification of living organisms into three domains of life (bacteria, archaea and eukarya), which one of the following statements is true about archaea?
(1) Archaea completely differ from both prokaryotes and eukaryotes.
(2) Archaea completely differ from prokaryotes.
(3) Archaea resemble eukarya in all respects.
(4) Archaea have some novel features that are absent in other prokaryotes and eukaryotes.

2007

77. Which one of the following statements about mycoplasma is wrong?
(1) They are pleomorphic.
(2) They are sensitive to penicillin.
(3) They cause diseases in plants.
(4) They are also called PPLO.

2007

78. Which one of the following is a slime mould?
(1) Physarum
(2) Thiobacillus
(3) Anabaena
(4) Rhizopus

2007

79. Which pair of the following belongs to basidiomycetes?
(1) Puffballs and Claviceps
(2) Peziza and stink horns
(3) Morchella and mushrooms
(4) Birds nest fungi and puffballs

2006

80. Curing of tea leaves is brought about by the activity of
(1) fungi
(2) bacteria
(3) mycorrhiza
(4) viruses.

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2006

81. Which of the following environmental conditions are essential for optimum growth of Mucor on a piece of bread ?

A. Temperature of about 25°C
B. Temperature of about 5°C
C. Relative humidity of about 5%
D. Relative humidity of about 95%
E. A shady place
F. A brightly illuminated place

Choose the answer from the following options.

(1) B, C and F only
(2) A, C and E only
(3) A, D and E only
(4) B, D and E only

2005

82. All of the following statements concerning the actinomycetous filamentous soil bacterium Frankia are correct except that Frankia

(1) can induce root nodules on many plant species
(2) can fix nitrogen in the free-living state
(3) cannot fix specialized vesicles in which the nitrogenase is protected from oxygen by a chemical barrier involving triterpene hopanoids
(4) like Rhizobium, it usually infects its host plant through root hair deformation and stimulates cell proliferation in the host's cortex.

2005

83. For retting of jute the fermenting microbe used is

(1) methanophilic bacteria
(2) butyric acid bacteria
(3) Helicobacter pylori
(4) Streptococcus lactin.

2005

84. Basophilic prokaryotes

(1) grow and multiply in very deep marine sediments
(2) occur in water containing high concentrations of barium hydroxide
(3) readily grow and divide in sea water enriched in any soluble salt of barium
(4) grow slowly in highly alkaline frozen lakes at high altitudes.

2005

85. Auxospores and hormogonia are formed, respectively, by

(1) some diatoms and several cyanobacteria
(2) some cyanobacteria and many diatoms
(3) several cyanobacteria and several diatoms
(4) several diatoms and a few cyanobacteria.

2005

86. There exists a close association between the alga and the fungus within a lichen. The fungus

(1) provides protection, anchorage and absorption for the algae
(2) provides food for the alga
(3) fixes the atmospheric nitrogen for the alga
(4) releases oxygen for the alga.

2004

87. When a fresh-water protozoan possessing a contractile vacuole, is placed in a glass containing marine water, the vacuole will

(1) increase in number
(2) disappear
(3) increase in size
(4) decrease in size.

2004

88. Which of the following statements is not true for retroviruses?

(1) DNA is not present at any stage in the life cycle of retroviruses.
(2) Retroviruses carry gene for RNA-dependent DNA polymerase.
(3) The genetic material in mature retroviruses is RNA.
(4) Retroviruses are causative agents for certain kinds of cancer in man.

2004

89. Viruses that infect bacteria multiply and cause their lysis, are called

(1) lysozymes (2) lipolytic
(3) lytic (4) lysogenic.

2004

90. Lichens are well known combination of an alga and a fungus where fungus has

(1) a saprophytic relationship with the alga
(2) an epiphytic relationship with the alga
(3) a parasitic relationship with alga
(4) a symbiotic relationship with alga.

NODIA

2003

91. In which kingdom would you classify the archaea and nitrogen-fixing organisms, if the five kingdom system of classification is used?

(1) Plantae (2) Fungi
(3) Protista (4) Monera

2003

92. The chief advantage of encystment of an Amoeba is
(1) the ability to survive during adverse physical conditions
(2) the ability to live for sometime without ingesting food
(3) protection from parasites and predators
(4) the chance to get rid of accumulated waste products.

2003

93. Which one of the following statements about viruses is correct ?
(1) Viruses possess their own metabolic system.
(2) All viruses contain both RNA and DNA.
(3) Viruses are obligate parasites.
(4) Nucleic acid of viruses is known as capsid.

2003

94. Tobacco mosaic virus is a tubular filament of size
(1) 300×10 nm
(2) 300×5 nm
(3) 300×20 nm
(4) 700×30 nm.

2003

95. Viruses are no more "alive" than isolated chromosomes because
(1) they require both RNA and DNA
(2) they both need food molecules
(3) they both require oxygen for respiration
(4) both require the environment of a cell to replicate.

2002

96. In five kingdom system, the main basis of classification is
(1) structure of nucleus
(2) mode of nutrition
(3) structure of cell wall
(4) asexual reproduction.

2002

97. Which statement is correct for bacterial transduction?
(1) Transfer of some genes from one bacteria to another bacteria through virus.
(2) Transfer of genes from one bacteria to another bacteria by conjugation.
(3) Bacteria obtained its DNA directly from mother cell.
(4) Bacteria obtained DNA from other external source.

2002

98. In bacteria, plasmid is
(1) extra chromosomal material
(2) main DNA
(3) non functional DNA
(4) repetitive gene.

2002

99. Organisms which obtain energy by the oxidation of reduced inorganic compounds are called
(1) photoautotrophs
(2) chemoautotrophs
(3) saprozoic
(4) coproheterotrophs.

2002

100. In which of the following animals dimorphic nucleus is found?
(1) Amoeba proteus
(2) Trypanosoma gambiense
(3) Plasmodium vivax
(4) Paramecium caudatum

2002

101. In protozoa like Amoeba and Paramecium, the organ for osmoregulation is
(1) contractile vacuole
(2) mitochondria
(3) nucleus
(4) food vacuole.

2002

102. Which fungal disease spreads by seed and flowers?
(1) Loose smut of wheat
(2) Corn smut
(3) Covered smut of barley
(4) Soft rot of potato

2002

103. Which of the following secretes toxins during storage conditions of crop plants?
(1) Aspergillus
(2) Penicillium
(3) Fusarium
(4) Colletotrichum

2001

104. What is true for archaebacteria?
(1) All halophiles
(2) All photosynthetics
(3) All fossils
(4) Oldest living beings

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2001

105. Difference in Gram positive and Gram negative bacteria is due to
(1) cell wall
(2) cell membrane
(3) ribosome
(4) cytoplasm.

2001

106. Cauliflower mosaic virus contains
(1) ss RNA
(2) ds RNA
(3) ds DNA
(4) ss DNA.

2000

107. Black rust of wheat is caused by
(1) Puccinia
(2) Ustilago
(3) Albugo
(4) Phytophthora.

1999

108. Columella is a specialized structure found in the sporangium of
(1) Spirogyra
(2) Ulothrix
(3) Rhizopus
(4) none of these.

1998

109. In the five kingdom system of classification, which single kingdom out of the following can include blue-green algae, nitrogen fixing bacteria and methanogenic archaebacteria?
(1) Plantae
(2) Protista
(3) Monera
(4) Fungi

1998

110. Transfer of genetic information from one bacterium to another in the transduction process is through
(1) bacteriophages released from the donor bacterial strain
(2) another bacterium having special organ for conjugation
(3) physical contact between donor and recipient strains
(4) conjugation between opposite strain bacterium.

1998

111. A bacterium divides every 35 minutes. If a culture containing 10^5 cells per mL is grown for 175 minutes, what will be the cell concentration per mL after 175 minutes?
(1) 35×10^5 cells/mL
(2) 32×10^5 cells/mL
(3) 175×10^5 cells/mL
(4) 85×10^5 cells/mL

1998

112. The DNA of E.coli is
(1) double stranded and linear
(2) double stranded and circular
(3) single stranded and linear
(4) single stranded and circular.

1998

113. The main role of bacteria in the carbon cycle involves
(1) chemosynthesis
(2) digestion or breakdown of organic compounds
(3) photosynthesis
(4) assimilation of nitrogenous compounds.

NODIA

1998

114. A few organisms are known to grow and multiply at temperatures of 100-105°C. They belong to
(1) thermophilic sulphur bacteria
(2) hot spring blue-green algae
(3) methanogenic archaebacteria
(4) marine archaebacteria.

1998

115. Puccinia forms uredia and
(1) telia on wheat leaves
(2) aecia on barberry leaves
(3) pycnia on barberry leaves
(4) aecia on wheat leaves.

1997

116. The hereditary material present in the bacterium E.coli is
(1) single-stranded DNA
(2) double-stranded DNA
(3) DNA
(4) RNA.

1997

117. Viruses possess
(1) ribosomes to synthesize protein
(2) organelle for its vital mechanism
(3) either DNA or RNA
(4) none of these.

1997

118. Most of the lichens consist of
(1) green algae and ascomycetes
(2) brown algae and higher plant

(3) blue green algae and basidiomycetes
(4) red algae and ascomycetes.

1996

119. BGA (blue green algae) are included in which of the following groups?
(1) Bryophytes
(2) Prokaryotes
(3) Protista
(4) Fungi

1996

120. Azotobacter and Bacillus polymyxa are the examples of
(1) pathogenic bacteria
(2) decomposers
(3) symbiotic N_2 fixer
(4) non-symbiotic N_2 fixer.

1996

121. What are the sex organs provided in some bacteria?
(1) Sex pili
(2) Plasmid
(3) Circular DNA
(4) Gametes

1996

122. Which type of DNA is found in bacteria?
(1) Circular free DNA
(2) Membrane bound DNA
(3) Straight DNA
(4) Helical DNA

1996

123. Mycorrhiza is correctly described as
(1) parasitic association between roots and some fungi
(2) symbiotic relationship between fungi and roots of some higher plants
(3) symbiosis of algae and fungi
(4) relation of ants with the stem of some trees.

1996

124. What is the genetic material in influenza virus?
(1) Double helical DNA
(2) RNA
(3) Single helix DNA
(4) None of these

1996

125. Which one of the following statement about lichens is wrong?
(1) These grow very rapidly (2 cm per day).
(2) They show fungal and algal symbiotic relationships.
(3) Some of its species are eaten by reindeers.
(4) These are pollution indicators.

1995

126. A large number of organic compounds can be decomposed by
(1) Azotobacter
(2) Chemolithotrophs
(3) Mycoplasma
(4) Pseudomonas.

1995

127. Which of the following organisms possesses characteristics of a plant and an animal?
(1) Euglena (2) Paramecium
(3) Bacteria (4) Mycoplasma

1995

128. The function of contractile vacuole, in protozoa, is
(1) osmoregulation
(2) reproduction
(3) locomotion
(4) digestion of food.

1995

129. The black rust of wheat is a fungal disease caused by
(1) Albugo candida
(2) Puccinia graminis tritici
(3) Melampsora lini
(4) Claviceps purpurea.

1995

130. The tailed bacteriophages are
(1) motile on surface of bacteria
(2) non-motile
(3) motile on surface of plant leaves
(4) actively motile in water.

1994

131. Many blue-green algae occur in thermal springs (hot-water springs). The temperature tolerance of these algae have been attributed to their
(1) mitochondrial structure
(2) importance of homopolar bonds in their proteins
(3) cell wall structure
(4) modern cell organization.

1994

132. Organisms, which fix atmospheric nitrogen in the soil, fall under the category of
(1) bacteria (2) green algae
(3) soil fungi (4) mosses.

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1994

133. Transduction in bacteria is mediated by
(1) plasmid vectors
(2) phage vectors
(3) cosmids
(4) F-factors.

1994

134. The protists have
(1) only free nucleic acid aggregates
(2) membrane bound nucleoproteins lying embedded in the cytoplasm
(3) gene containing nucleoproteins condensed together in loose mass
(4) nucleoprotein in direct contact with the rest of the cell substance.

1994

135. Tobacco mosaic virus (TMV) genes are
(1) single stranded RNA
(2) double stranded DNA
(3) proteinaceous
(4) double stranded RNA.

1993

136. Genophore/bacterial genome or nucleoid is made of
(1) histones and non-histones
(2) RNA and histones
(3) a single double stranded DNA
(4) a single stranded DNA.

1993

137. Escherichia coli is used extensively in biological research as it is
(1) easily cultured
(2) easily available
(3) easy to handle
(4) easily multiplied in host.

1992, 1991

138. Bacteria lack alternation of generation because there is
(1) neither syngamy nor reduction division
(2) distinct chromosomes are absent
(3) no conjugation
(4) no exchange of genetic material.

1992

139. Organisms which are indicator of SO_2 pollution of air
(1) mosses
(2) lichens
(3) mushrooms
(4) puffballs.

1991

140. An important criterion for modern day classification is
(1) resemblances in morphology
(2) anatomical and physiological traits
(3) breeding habits
(4) presence or absence of notochord.

1991

141. Name the organisms which do not derive energy directly or indirectly from sun.
(1) Chemosynthetic bacteria
(2) Pathogenic bacteria
(3) Symbiotic bacteria
(4) Mould

1991

142. In Amoeba and Paramecium osmoregulation occurs through
(1) pseudopodia
(2) nucleus
(3) contractile vacuole
(4) general surface.

1990

143. The main difference in Gram (+)ve and Gram (-)ve bacteria resides in their
(1) cell wall
(2) cell membrane
(3) cytoplasm
(4) flagella.

1990

144. Which one belongs to Monera?
(1) Amoeba
(2) Escherichia
(3) Gelidium
(4) Spirogyra

1990

145. Plasmodium, the malarial parasite, belongs to class
(1) sarcodina
(2) ciliata
(3) sporozoa
(4) dinophyceae.

1990

146. Which is true about Trypanosoma?
(1) Polymorphic
(2) Monogenetic
(3) Facultative parasite
(4) Non-pathogenic

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1990

147. Genetic information in Paramecium is contained in
(1) micronucleus
(2) macronucleus
(3) both micronucleus and macronucleus
(4) mitochondria.

1990

148. Absorptive heterotrophic nutrition is exhibited by
(1) algae
(2) fungi
(3) bryophytes
(4) pteridophytes.

1989

149. Trypanosoma belongs to Class
(1) Sarcodina
(2) Zooflagellata
(3) Ciliata
(4) Sporozoa.

1989

150. Lichens indicate SO_2 pollution because they
(1) show association between algae and fungi
(2) grow faster than others
(3) are sensitive to SO_2
(4) flourish in SO_2 rich environment.

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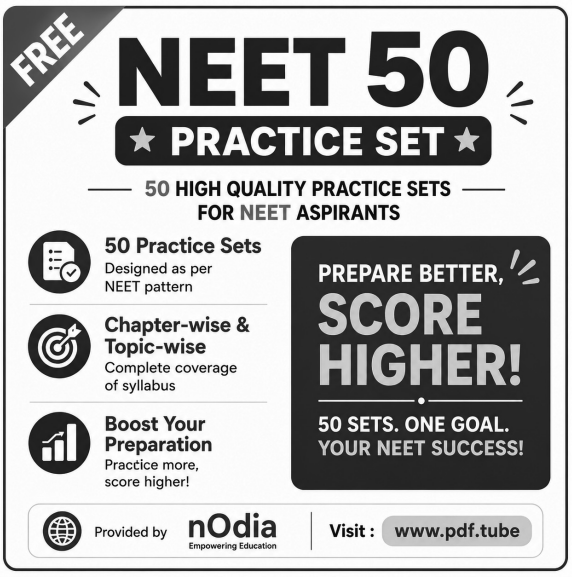

ANSWERS

1. (3) A-II, B-III, C-I
Fusion of protoplasms between gametes is plasmogamy (II). Fusion of two nuclei is karyogamy (III). Generation of haploid spores occurs through meiosis (I). This gives A-II, B-III, C-I, representing events in sexual reproduction of many fungi.

2. (3) prions
Mad cow disease (Bovine Spongiform Encephalopathy) is caused by prions, abnormal infectious protein particles. These misfolded proteins induce normal brain proteins to misfold, leading to degeneration of the nervous system. Prions lack nucleic acid, distinguishing them from viruses and viroids.

3. (2) A-II, B-IV, C-I, D-III
Spherical bacteria are cocci (II), rod-shaped are bacilli (IV), comma-shaped are vibrio (I), and spiral are spirilla (III). This gives A-II, B-IV, C-I, D-III based on the shapes of different bacterial forms.

4. (2) Fungi
Fungi are eukaryotic organisms possessing a true membrane-bound nucleus and organelles. Mycoplasma, bacteria and blue green algae (cyanobacteria) are all prokaryotes lacking a true nucleus. Therefore fungi do not belong to prokaryotes.

5. (3) lichens
Lichens are symbiotic associations between a fungus (mycobiont) and an alga (phycobiont). The alga makes food by photosynthesis while the fungus provides shelter, water and minerals. Mycorrhiza is the association between fungi and plant roots.

6. (3) A, B, D and E only
Whittaker's Five Kingdom Classification was based on cell structure, body organisation, mode of nutrition, reproduction and phylogenetic relationships. Presence of flagellum was not a main criterion. Hence the correct combination is A, B, D and E only (nutrition being the additional criterion not listed here).

7. (4) C, E, A, D, B
Whittaker's five-kingdom classification follows a hierarchical progression in body organization complexity. The sequence begins with prokaryotic Monera, followed by unicellular eukaryotic Protista. Next are multicellular eukaryotes, starting with fungi having chitinous walls, then plants with tissue or organ levels, and finally animals possessing organ systems. This arrangement reflects the evolutionary transition from simple cells to highly complex systems.

8. (3) A-IV, B-III, C-II, D-I
Protists exhibit diverse nutritional strategies according to their specific groups. Euglenoids are mixotrophic, performing photosynthesis in light but becoming heterotrophic in its absence. Dinoflagellates primarily function as photosynthetic producers. Slime moulds act as saprophytes, consuming organic matter from decaying substrates. Plasmodium, an apicomplexan protozoan, is an obligate parasite causing diseases such as malaria in various hosts.

9. (1) A-III, B-II, C-IV, D-I
Specific fungi are commonly identified by their descriptive names based on their growth habits or appearances. Rhizopus is widely known as bread mould due to its common occurrence on starchy foods. Ustilago causes smut diseases in crops, while Puccinia is the agent behind rust infections. Agaricus represents the typical edible mushroom group, reflecting diversity within the fungal kingdom.

10. (2) Mode of nutrition
Fungal classification relies on multiple structural and reproductive features to distinguish between major groups. Primary criteria include the morphology of the mycelium, the specific mode of spore formation, and the type of fruiting bodies produced. While nutritional habits are fundamental to the kingdom, they are not used as a diagnostic feature to differentiate classes like Phycomycetes or Ascomycetes.

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11. (3) Statement I is correct but Statement II is incorrect
Mycoplasma represent a unique group of organisms characterized by several distinct biological features. These organisms are the smallest known living cells and are capable of passing through filters that typically trap bacteria. They are distinguished from other bacteria by the total lack of a cell wall, which makes them naturally resistant to antibiotics that target wall synthesis.

12. (1) Cyanobacteria are a group of autotrophic organisms classified under Kingdom Monera.
Cyanobacteria, commonly known as blue-green algae, are photosynthetic autotrophs classified within Kingdom Monera. Unlike heterotrophic bacteria, they possess chlorophyll a similar to green plants. Other groups like slime moulds are eukaryotic and belong to Kingdom Protista. Additionally, mycoplasma lack cell walls, and many bacteria are autotrophic, contradicting the idea that bacteria are exclusively heterotrophic organisms.

13. (3) Fusion of protoplasms between two motile or non-motile gametes is called plasmogamy.
Plasmogamy is the initial stage of sexual reproduction in fungi and certain protists, involving the fusion of protoplasms. This process occurs between two motile or non-motile gametes without the immediate fusion of their nuclei. This stage is followed by karyogamy and meiosis. Other processes like nitrogen fixation occur in specialized cells called heterocysts, rather than in generic sheath cells.

14. (2) They have free RNA without protein coat.
Viroids are infectious agents that are even smaller than viruses and consist only of a low molecular weight RNA. Unlike viruses, viroids completely lack a protein coat or capsid to protect their genetic material. This free RNA molecule is sufficient to cause various diseases, particularly in plants, by interfering with the host's normal cellular processes and regulatory mechanisms.

15. (1) A-(iv), B-(i), C-(iii), D-(ii)
Archaebacteria and cyanobacteria thrive in specific environments tailored to their metabolic needs. Halophiles are found in extremely salty areas, while thermoacidophiles inhabit hot springs with high acidity. Methanogens are typically located in the anaerobic guts of ruminant animals. Cyanobacteria are primarily aquatic organisms. Matching these organisms to their specific habitats demonstrates the ecological diversity found within the kingdom Monera.

16. (1) Yeasts have filamentous bodies with long thread like hyphae.
Yeasts are unique members of the fungal kingdom because they are primarily unicellular and do not form filamentous hyphae. Most other fungi develop long, thread-like structures that comprise the mycelium. In contrast, morels and truffles are highly valued edible fungi. Claviceps serves as a source for alkaloids, and the production of spores like conidia occurs through exogenous processes.

17. (1) A-(ii), B-(iii), C-(iv), D-(i)
Organisms establish various ecological relationships based on their nutritional requirements and life cycles. Saprophytes survive by decomposing dead organic matter, while parasites live on or within living hosts. Symbiotic associations are also common, such as lichens formed between algae and fungi. Similarly, mycorrhiza represents a mutualistic relationship between fungi and the roots of higher plants to improve nutrient uptake.

18. (2) abnormally folded protein
Bovine spongiform encephalopathy, commonly known as mad cow disease, is a progressive neurological disorder in cattle. It is caused by prions, which are infectious agents composed entirely of abnormally folded proteins. These pathogens lack any nucleic acids like DNA or RNA. The misfolded proteins induce normal brain proteins to also fold abnormally, leading to severe brain damage and death.

19. (4) Infective constituent in viruses is the protein coat.
Viruses are complex infectious agents where the genetic material, either DNA or RNA, constitutes the actual infective component. The protein coat, known as the capsid, serves primarily to protect this nucleic acid and facilitate entry into host cells. While prions are misfolded proteins and viroids lack protein coats, viruses remain obligate parasites that must utilize a host's machinery.

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20. (2) Diatoms
Diatoms are microscopic eukaryotic organisms found in aquatic environments and are classified within the group Chrysophytes. They are characterized by unique silica-based cell walls that form two overlapping shells. Due to their immense abundance and high photosynthetic activity, diatoms serve as the primary chief producers in the oceans, forming the fundamental base of the marine food web and ecosystem.

21. (4) having two types of nuclei.
Ciliates represent a specialized group of protozoans characterized by the presence of thousands of cilia for movement and feeding. A unique feature of this group is nuclear dimorphism, where each cell contains two types of nuclei. The large macronucleus controls vegetative functions and metabolism, while the small micronucleus is responsible for genetic recombination during the process of sexual conjugation.

22. (1) Saccharomyces
Prokaryotes are organisms that lack a membrane-bound nucleus and other specialized organelles, encompassing groups like bacteria and cyanobacteria. Mycobacterium, Nostoc, and Oscillatoria are all examples of prokaryotic monerans. In contrast, Saccharomyces, commonly known as yeast, is a unicellular fungus. As a member of the fungal kingdom, it possesses a true nucleus and membrane-bound organelles, making it a eukaryote.

23. (3) Agaricus
Agaricus is a member of the Basidiomycetes group, which produces sexual spores known as basidiospores. These spores are formed exogenously on the surface of a club-shaped structure called a basidium following the processes of karyogamy and meiosis. This contrasts with Ascomycetes like Neurospora and Saccharomyces, which produce ascospores endogenously within a sac-like structure called an ascus during their lifecycle.

24. (3) Pseudopodia are locomotory and feeding structures in sporozoans.
Protozoans are classified into groups based on their locomotory structures, such as flagellates, ciliates, and amoeboids. Amoeboids use pseudopodia for movement and capturing prey, but sporozoans like Plasmodium lack any specialized locomotory organs. Other kingdoms like fungi and plants possess cell walls, while mitochondria are absent only in monerans. Mushrooms are correctly identified as members of the Basidiomycetes group.

25. (4) Archaebacteria
Archaebacteria are a primitive group of prokaryotes known for their ability to survive in some of the harshest environments on Earth. Halophiles are a specific category of archaebacteria that are adapted to live in extremely saline conditions, such as salt lakes. Their unique cell membrane and wall structures allow them to maintain cellular integrity despite the high external osmotic pressure.

26. (2) Mycoplasma
Mycoplasma are distinct organisms that represent the smallest known living cells capable of independent existence. They are characterized by the complete absence of a cell wall, which allows them to change shape easily. These organisms can survive in anaerobic conditions without oxygen and are known to be pathogenic to various plants and animals, causing a range of respiratory and systemic diseases.

27. (3) Glycocalyx
The bacterial cell envelope often includes an outer coating called the glycocalyx, which lies external to the cell wall. This layer can exist as a loose slime layer or a thick, tough capsule. The glycocalyx is composed of polysaccharides and proteins, which provide a sticky character to the cell. This stickiness helps bacteria adhere to host tissues or various environmental surfaces.

28. (2) prior to fission
Bacteria are prokaryotic organisms that reproduce primarily through the process of binary fission. In these organisms, the replication of the circular DNA molecule occurs in the cytoplasm just before the cell undergoes division. This ensures that each daughter cell receives a complete copy of the genetic material. Unlike eukaryotes, bacteria do not have a defined S phase within a cell cycle.

29. (3) RNA molecules without protein coat
Viroids and viruses are both infectious agents, but they differ significantly in their structural composition. Viroids consist solely of a short, circular strand of infectious RNA without any protective protein coat. In contrast, viruses

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possess a genetic core made of either DNA or RNA, which is always enclosed within a protein shell known as a capsid. Viroids primarily cause plant diseases.

30. (2) archaebacteria
Methanogens are a specialized group of archaebacteria that thrive in anaerobic environments, such as marshes and the digestive tracts of various animals. These organisms are known for their unique metabolic capability to produce methane gas as a byproduct of their respiration. Their classification within archaebacteria is based on their distinct ribosomal RNA sequences and unique cell wall and membrane lipids.

31. (1) methanogens
Methanogens are primitive prokaryotes classified as archaebacteria that live in anaerobic habitats. They are found in the rumen of cattle and other ruminants, where they assist in the breakdown of cellulose. During this process, they produce methane gas, which is the primary component of biogas. These organisms are essential for the production of renewable energy from animal waste and dung.

32. (1) The walls of diatoms are easily destructible.
Diatoms are unique aquatic organisms with cell walls composed of two thin, overlapping shells made of silica. This silica makes the walls incredibly durable and nearly indestructible. Over millions of years, the accumulation of these discarded walls on the ocean floor forms large deposits known as diatomaceous earth. Diatoms are also the chief photosynthetic producers in marine environments, floating passively.

33. (4) Protista.
Kingdom Protista serves as a diverse group that includes all unicellular eukaryotic organisms. This kingdom encompasses several distinct groups with varying modes of nutrition and movement, such as photosynthetic Chrysophytes, Dinoflagellates, and Euglenoids. It also includes heterotrophic or saprophytic organisms like slime moulds and protozoans. By grouping these together, the classification system highlights their common eukaryotic nature despite their varied lifestyles.

34. (2) All fungi possess a purely cellulosic cell wall.
Fungi are a kingdom of eukaryotic, heterotrophic organisms that exhibit a wide range of forms, from unicellular yeasts to multicellular mushrooms. One of their defining characteristics is the composition of their cell wall, which is primarily made of chitin and other polysaccharides. This distinguishes them from plants, which have cellulosic walls. Fungi play vital roles as decomposers, parasites, or mutualistic partners.

35. (1) Eubacteria are also called false bacteria.
Bacterial classification distinguishes between different types of organisms based on their structural and metabolic properties. Eubacteria are referred to as true bacteria, not false bacteria, because they possess a rigid cell wall and often move using flagella. Other groups include cyanobacteria, which are blue-green algae, and chrysophytes like golden algae or desmids. Phycomycetes are frequently called algal fungi due to certain similarities.

36. (3) chitin
The cell wall is a critical structural component in most fungi, providing protection and maintaining cell shape. This wall is primarily composed of chitin, a tough nitrogen-containing polysaccharide, along with various glucans. This chemical composition is a fundamental characteristic that separates fungi from plants, which use cellulose, and from bacteria, which use peptidoglycan. Chitin provides the necessary rigidity for fungal growth.

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37. (2) Their RNA is of high molecular weight.
Viroids are unique infectious agents discovered to be smaller than viruses. They consist entirely of a short, circular, single-stranded RNA molecule that lacks a protective protein coat. One key characteristic of viroid RNA is that it has a low molecular weight. Despite their simple structure, viroids are potent pathogens that cause several diseases in plants by interfering with host metabolism.

38. (3) Chrysophytes
Chrysophytes include a group of organisms known as diatoms, which are found in both freshwater and marine environments. Their cell walls are unique because they consist of two thin, overlapping shells that fit together like a soap box. These walls are embedded with silica, making them extremely hard and resistant to

decay, which eventually leads to the formation of diatomaceous earth.

39. (3) Deuteromycetes
Deuteromycetes are often referred to as the imperfect fungi because their sexual stages are either unknown or do not exist. Many members of this group are saprophytes or parasites, but a large number function as efficient decomposers of organic litter. By breaking down complex organic materials, they play a crucial role in mineral cycling and nutrient availability within various terrestrial ecosystems.

40. (1) Morels and truffles are poisonous mushrooms.
Fungi serve many roles, ranging from industrial applications to scientific research. Yeast is a unicellular organism vital for fermentation in brewing and baking. Penicillium is a multicellular fungus used to produce life-saving antibiotics. Neurospora is a key model organism in biochemical genetics. However, morels and truffles are highly prized edible delicacies and are not poisonous, unlike some other wild mushrooms.

41. (4) Alternaria Sexual reproduction absent Deuteromycetes
Fungi are classified based on their reproductive methods and mycelial structure. Alternaria belongs to the Deuteromycetes, a group where sexual reproduction has not been observed, earning them the name imperfect fungi. Other fungi like Mucor are Phycomycetes, while Agaricus is a member of the Basidiomycetes. The absence of a known sexual cycle is the defining diagnostic feature for placing Alternaria in Deuteromycetes.

42. (1) Mycoplasma
The cell wall is a protective outer layer found in many groups of organisms, including bacteria like Nostoc, fungi like Aspergillus, and plants like Funaria. However, Mycoplasma are unique prokaryotes that naturally lack a cell wall entirely. This absence makes them highly pleomorphic and resistant to common antibiotics that function by inhibiting cell wall synthesis, such as the penicillin group.

43. (3) Anabaena
A true nucleus is a membrane-bound organelle containing genetic material, which is a defining feature of eukaryotic organisms like Vaucheria, Volvox, and Mucor. In contrast, Anabaena is a cyanobacterium and belongs to the Kingdom Monera. As a prokaryote, it lacks a defined nucleus and other membrane-bound organelles. Its genetic material is located directly in the cytoplasm in a region called the nucleoid.

44. (2) Nuclear membrane is present in Monera.
Biological classification separates organisms based on their cellular structure and nutritional modes. Kingdom Monera is comprised of prokaryotes that lack a defined nuclear membrane and membrane-bound organelles. Other kingdoms like Protista include both photosynthetic and heterotrophic organisms. Fungi may be edible, while organisms in Kingdom Animalia are characterized by the complete absence of a cell wall, distinguishing them from plants and fungi.

45. (3) The viroids were discovered by D.J. Ivanowsky.
The history of virology involves several key discoveries regarding infectious agents. M.W. Beijerinck coined the term meaning infectious living fluid to describe viruses. W.M. Stanley demonstrated that viruses could be crystallized, showing their non-living characteristics. While Ivanowsky identified the tobacco mosaic pathogen, viroids were actually discovered by T.O. Diener in 1971, identifying them as free infectious RNA molecules without protein coats.

46. (1) presence or absence of a well defined nucleus
R.H. Whittaker proposed the five-kingdom classification system based on five primary criteria for categorizing life. These include the complexity of cell structure, such as prokaryotic versus eukaryotic organization, and the complexity of the organism's body. Other major factors are the mode of nutrition, reproduction, and phylogenetic relationships. While cell structure is a basis, specific definitions of nuclei are part of that category.

47. (1) cell membrane structure
Archaebacteria and eubacteria are both prokaryotic but differ significantly in their chemical composition and structure. The most notable difference lies in the cell wall structure, which, along with unique membrane lipids, provides archaebacteria with extraordinary stability, allowing them to survive in extreme environments such as high heat or high salinity. This unique structure distinguishes them from

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the peptidoglycan-based walls and straight-chain lipids found in eubacteria.

48. (2) Amanita muscaria
Certain fungi produce secondary metabolites that can have profound effects on the human nervous system. Amanita muscaria, commonly known as the fly agaric mushroom, is a well-known example that contains psychoactive compounds such as muscimol. These substances act as hallucinogens when ingested. In contrast, other fungi like Morchella are edible, while species of Neurospora and Ustilago are used in research or cause plant diseases.

49. (2) Sea-fan (Gorgonia)
The presence or absence of a cell wall is a fundamental trait used to distinguish between different kingdoms of life. Cyanobacteria and blue-green algae are prokaryotes with cell walls, and Saccharomyces is a fungus that also possesses a wall. However, Gorgonia, commonly known as the sea-fan, belongs to the Kingdom Animalia. Animals are uniquely characterized by the total absence of cell walls.

50. (2) Tobacco mosaic virus
Tobacco mosaic virus is a classic example of a plant virus with a simple yet elegant structure. It consists of a single-stranded RNA molecule that is arranged in a coiled or helical fashion. This genetic material is protected by a protein coat called a capsid, which is made up of numerous small repeating subunits known as capsomeres. This arrangement forms a rod-shaped particle.

51. (1) DNA enclosed in a protein coat
Viruses are non-cellular infectious agents that consist of a genetic core surrounded by a protective protein shell. This genetic material can be either DNA or RNA, but never both in the same virus particle. The protein shell, or capsid, serves to protect the nucleic acid from the environment. Viruses lack a nucleus, chromosomes, or any metabolic machinery of their own.

52. (3) Archaebacteria
Deep sea environments are characterized by extreme conditions, including high pressure, lack of light, and sometimes very high temperatures near hydrothermal vents. Archaebacteria are a group of ancient prokaryotes specifically adapted to thrive in such harsh surroundings. Their unique cellular chemistry and membrane structures allow them to remain functional where most other life forms, including eubacteria and algae, cannot survive.

53. (2) chromatophores
Cyanobacteria are prokaryotes that perform photosynthesis using pigments located on specialized internal membranes. In some species, particularly those that are filamentous, these membranous extensions are called chromatophores. These structures contain chlorophyll a and other accessory pigments necessary for capturing light energy. They differ from other specialized cells like heterocysts, which are used for nitrogen fixation, or pneumatophores used for gas exchange.

54. (2) They are heterotrophs.
Fungi are a distinct kingdom of eukaryotic organisms that share several key biological characteristics. All fungi are heterotrophs, meaning they cannot produce their own food and must absorb nutrients from organic matter. They possess a rigid cell wall usually made of chitin and a well-defined nuclear membrane. Unlike some protozoans, they typically absorb nutrients rather than engulfing food particles through phagotrophy.

55. (3) monera.
Kingdom Monera exhibits the highest degree of nutritional diversity among all living organisms. Members of this kingdom include various bacteria that can be autotrophic, producing food through photosynthesis or chemosynthesis. Additionally, many are heterotrophic, acting as saprophytes that decompose organic matter or as parasites. This metabolic flexibility allows monerans to colonize almost every habitat on Earth, utilizing a wide range of energy sources.

56. (1) protista
In early classification systems, Chlamydomonas and Chlorella were placed with plants or algae because they are photosynthetic. However, the five-kingdom system emphasizes cellular organization alongside other traits. Since these organisms are unicellular eukaryotes, they were moved to Kingdom Protista. This kingdom was specifically designed to include all single-celled eukaryotic organisms, regardless of whether they resemble plants, animals, or fungi in their nutrition.

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57. (4) blue green algae.
Cyanobacteria represent a major group of photosynthetic prokaryotes that have historically been called blue-green algae. This name originates from their color, produced by pigments like chlorophyll a and phycobilins, and their aquatic nature. Despite the name, they are true bacteria and belong to Kingdom Monera, not the eukaryotic algae. They play a vital role in oxygen production and nitrogen fixation in various ecosystems.

58. (4) heterotrophic bacteria.
Heterotrophic bacteria are the most abundant prokaryotes in nature and perform many functions that are beneficial to humans. These bacteria are responsible for biological processes such as converting milk into curd and producing various antibiotics. They also play a major role as decomposers in ecosystems. This category excludes autotrophic groups like cyanobacteria, which produce their own food through photosynthesis or chemical energy.

59. (4) Nostoc.
The nuclear membrane is a defining feature of eukaryotic cells, present in fungi like Penicillium and Agaricus, and algae like Volvox. However, Nostoc is a cyanobacterium belonging to Kingdom Monera. As a prokaryote, it lacks membrane-bound organelles, including a defined nucleus. Its genetic material is located in a nucleoid region, where it remains in direct contact with the cytoplasm without a membrane.

60. (2) All of them have helical symmetry.
Viruses are obligate parasites that require a host cell to replicate their nucleic acids and proteins. While many viruses exhibit helical or polyhedral symmetry, not all of them share the same structural shape. A significant biological characteristic of viruses is that they are unaffected by antibiotics, which are designed to target bacterial processes. They must use the metabolic machinery of their host.

61. (3) Yeast used in making bread and beer is a fungus.
Yeast is a unicellular fungus commonly used in the production of bread and beer through the process of fermentation. It is correctly classified within Kingdom Fungi. Other organisms like Paramecium and Plasmodium are protozoans belonging to Kingdom Protista. Lichens are symbiotic associations between algae and fungi, while Nostoc and Anabaena are prokaryotic cyanobacteria that belong to the Kingdom Monera.

62. (1) plasma membrane
Eubacteria are prokaryotic organisms, but they share some structural similarities with eukaryotes. One such component is the plasma membrane, which is composed of a lipid bilayer and proteins, similar in basic structure and function to the membranes found in eukaryotic cells. In contrast, eukaryotes possess a defined nucleus and different types of ribosomes and cell wall compositions that distinguish them from bacteria.

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63. (2) Escherichia coli
Eukaryotes are organisms whose cells contain a distinct, membrane-bound nucleus and other specialized organelles. Paramecium, Euglena, and Amoeba are all single-celled eukaryotes classified under Kingdom Protista. Escherichia coli, however, is a bacterium and therefore a prokaryote. It lacks a defined nucleus and membrane-bound organelles, with its genetic material situated in the nucleoid region of the cytoplasm.

64. (3) Rhizopus, a mould
Microsporum is a genus of fungi that causes skin infections such as ringworm in humans. Because it is a fungus, it belongs to Kingdom Fungi. Rhizopus, commonly known as bread mould, is also a member of the same kingdom. In contrast, organisms like Taenia, Wuchereria, and Ascaris are parasitic worms belonging to Kingdom Animalia, representing different levels of biological organization.

65. (1) eubacteria and archaea
Hyperthermophilic organisms are those that can survive and grow at very high temperatures, often in highly acidic environments with low pH. Such extreme conditions are typically inhabited by specific groups of prokaryotes, including certain eubacteria and members of the domain Archaea. These organisms have evolved unique proteins and membrane structures that remain stable and functional under conditions that would denature most biological molecules.

66. (4) (i), (ii) and (iv).
Methanogens are specialized archaebacteria found in marshy areas where they produce methane gas. Nostoc is a filamentous blue-green alga capable of fixing atmospheric nitrogen in specialized cells. Mycoplasma are the smallest living cells that lack a cell wall and can survive without oxygen. Chemosynthetic bacteria, however, obtain energy from inorganic chemicals and do not synthesize cellulose from glucose like plants.

67. (1) protista
Kingdom Protista was established to provide a unified classification for all single-celled eukaryotic organisms. This diverse group includes various life forms such as amoebae, protozoans, unicellular algae, and slime moulds. By grouping them together, the five-kingdom system separates them from prokaryotic monerans and multicellular fungi, plants, and animals. This kingdom serves as a taxonomic bridge between simple prokaryotes and complex multicellular life.

68. (2) Streptococcus
Membrane-bound organelles, such as mitochondria and chloroplasts, are a hallmark of eukaryotic cells. Streptococcus is a genus of bacteria, and as prokaryotes, they lack these internal membrane-bound structures. Their cellular processes occur directly in the cytoplasm or at the plasma membrane. In contrast, organisms like Saccharomyces, Chlamydomonas, and Plasmodium are all eukaryotes and possess a variety of specialized membrane-bound organelles.

69. (3) Puccinia graminis
Black stem rust is a devastating fungal disease that affects wheat crops globally. It is caused by the fungus Puccinia graminis. This pathogen is a heteroecious rust, meaning it requires two different host plants, wheat and barberry, to complete its complex life cycle. Other fungi like Ustilago and Alternaria cause different types of diseases, such as smut or blights, respectively.

70. (1) capsid
A virus is composed of genetic material surrounded by a protective protein shell known as the capsid. This capsid is made up of smaller protein subunits called capsomeres. While some viruses have an additional outer lipid envelope, the capsid is the fundamental structure that encloses the viral genome. The entire infectious particle, including the nucleic acid and its shell, is called a virion.

71. (3) Head Sheath Collar Tail fibres
A bacteriophage is a type of virus that infects bacteria and possesses a distinct structural organization. It typically consists of a head containing the genetic material and a neck region with a collar. A contractile sheath connects the head to a base plate, which is equipped with tail fibres used for attachment to the host bacterial cell surface during infection.

72. (4) Late blight of potato-Alternaria solani
Plant diseases are caused by specific pathogens, and matching them correctly is vital for agricultural science. Black rust of wheat is caused by Puccinia graminis, and loose smut is caused by Ustilago nuda. Early blight of potato is caused by Alternaria solani, but late blight of potato is actually caused by the oomycete Phytophthora infestans. Root knot is caused by Meloidogyne species.

73. (4) free infectious RNA.
In 1971, T.O. Diener discovered a new type of infectious agent that was significantly smaller than a virus. He identified these agents as viroids, which consist entirely of a short, free-living infectious RNA molecule. Unlike viruses, viroids do not have a protective protein coat. They are known to cause several diseases in plants, such as potato spindle tuber disease, by interfering with host functions.

74. (3) Xanthomonas.
Bacterial leaf blight is a serious disease of rice that can lead to significant crop loss. It is caused by the bacterium Xanthomonas oryzae. The pathogen enters the plant through wounds or natural openings and multiplies in the vascular tissues, leading to yellowing and wilting of the leaves. Other genera like Pseudomonas or Erwinia cause different types of plant infections and rots.

75. (3) archaebacteria that contain protein homologous to eukaryotic core histones
Certain archaebacteria, such as Thermococcus and Methanococcus, exhibit biological features that are interestingly similar to eukaryotes. These organisms possess proteins that are homologous

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to the core histones found in eukaryotic cells. These histones help in the packaging and organization of their DNA. This discovery highlights the complex evolutionary relationships between archaebacteria and eukaryotes, despite archaebacteria being prokaryotic in their overall organization.

76. (4) Archaea have some novel features that are absent in other prokaryotes and eukaryotes.
Archaea represent one of the three domains of life and, while prokaryotic, they possess several unique characteristics. They have distinct ribosomal RNA sequences and cell wall compositions that lack peptidoglycan. Additionally, they have novel biochemical features and metabolic pathways that are absent in both eubacteria and eukaryotes. These differences allow them to thrive in extreme environments and distinguish them from all other groups.

77. (2) They are sensitive to penicillin.
Mycoplasma are unique bacteria that completely lack a cell wall, which makes them highly pleomorphic and gives them the name PPLO. Because they have no cell wall, they are naturally resistant to antibiotics like penicillin, which work by inhibiting cell wall synthesis. They are the smallest living cells and can cause various diseases in both plants and animals, surviving even without oxygen.

78. (1) Physarum
Slime moulds are a unique group of saprophytic protists that exhibit characteristics of both fungi and amoebae. Physarum is a well-known genus of slime moulds that forms a multinucleated mass of protoplasm called a plasmodium during its vegetative phase. In contrast, Anabaena is a cyanobacterium, Rhizopus is a true fungus, and Thiobacillus is a type of chemoautotrophic bacterium.

79. (4) Birds nest fungi and puffballs
Basidiomycetes is a class of fungi characterized by the production of sexual spores on a club-shaped structure called a basidium. This group includes a wide variety of fungi such as mushrooms, puffballs, stink horns, and birds nest fungi. Other fungi like Claviceps, Peziza, and Morchella belong to the Ascomycetes, which produce their sexual spores within sac-like structures called asci.

80. (2) bacteria
The processing of tea leaves involves a stage called curing, which is essential for developing the characteristic flavor and aroma of the final product. This process is primarily brought about by the metabolic activity of certain bacteria, such as Micrococcus candidans. These microbes act on the chemical constituents of the leaves, facilitating fermentation and oxidative changes that enhance the quality of the tea.

81. (3) A, D and E only
Mucor is a common saprophytic fungus that requires specific environmental conditions for optimal growth on organic substrates like bread. It thrives best at moderate temperatures around twenty-five degrees Celsius. Additionally, a high relative humidity of approximately ninety-five percent provides the necessary moisture for hyphal expansion. Growth is also favored in shady or dark places rather than areas exposed to bright light.

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82. (3) cannot fix specialized vesicles in which the nitrogenase is protected from oxygen by a chemical barrier involving triterpene hopanoids
Frankia is a filamentous soil bacterium that forms a symbiotic relationship with many non-leguminous plants, inducing the formation of nitrogen-fixing root nodules. Like Rhizobium, it can also exist as a free-living organism in the soil, although it fixes nitrogen as a symbiont. To protect the sensitive nitrogenase enzyme from oxygen, Frankia develops specialized vesicles that possess a chemical barrier, ensuring efficient nitrogen fixation within the host plant tissues.

83. (2) butyric acid bacteria
Retting is a biological process used in the textile industry to separate fibers from the stems of plants like jute and flax. This process involves submerging the stems in water, where anaerobic bacteria perform fermentation. Butyric acid bacteria, such as Clostridium butyricum, are commonly involved in this breakdown. They decompose the pectin and other adhesive substances, allowing the valuable fibers to be easily extracted.

84. (1) grow and multiply in very deep marine sediments
Basophilic prokaryotes, more accurately known as barophiles, are organisms specifically adapted to live under extremely high hydrostatic pressure.

These specialized microbes are typically found in the deepest parts of the ocean, such as marine sediments and trenches. Their cellular components and enzymes are uniquely structured to remain functional and allow for growth and multiplication in these high-pressure, deep-sea environments.

85. (1) some diatoms and several cyanobacteria
Different groups of microorganisms have evolved specific structures for survival and reproduction. Diatoms, a group of photosynthetic protists, produce specialized cells called auxospores to restore their cell size during their life cycle. In contrast, several cyanobacteria form hormogonia, which are short filaments of cells that break away from the main colony to facilitate vegetative reproduction and dispersal in aquatic environments.

86. (1) provides protection, anchorage and absorption for the algae
A lichen is a mutualistic association between a fungus and a photosynthetic partner, such as an alga or cyanobacterium. In this relationship, the fungal component provides several essential benefits. It offers structural protection, serves as an anchorage to the substrate, and efficiently absorbs water and minerals from the environment. These resources are then shared with the alga, which produces food through photosynthesis.

87. (4) decrease in size.
Fresh-water protozoans use a contractile vacuole as an essential organelle for osmoregulation, helping to pump out excess water that enters the cell. When such an organism is moved to marine water, which has a higher salt concentration, the external environment becomes hypertonic. As a result, water leaves the cell by osmosis, reducing the need for the vacuole and causing it to decrease in size.

88. (1) DNA is not present at any stage in the life cycle of retroviruses.
Retroviruses are a family of viruses that use RNA as their primary genetic material. A key feature of their life cycle is the use of an enzyme called reverse transcriptase, or RNA-dependent DNA polymerase. This enzyme converts the viral RNA into DNA once the virus enters a host cell. Therefore, DNA is an essential intermediate stage in the life cycle of all retroviruses.

89. (3) lytic
Certain viruses are specialized to infect and replicate within bacterial cells, and these are known as bacteriophages. Some of these viruses follow a lytic cycle, where they take over the host cell's machinery to produce many new viral particles. At the end of this process, the host bacterium is broken open or lysed, releasing the newly formed viruses into the environment.

90. (4) a symbiotic relationship with alga.
Lichens represent a classic example of a symbiotic relationship between two different types of organisms. They consist of a fungal partner and a photosynthetic partner, which can be an alga or a cyanobacterium. In this mutualistic association, both organisms benefit. The fungus provides structural support and absorbs nutrients, while the alga produces organic food through photosynthesis, which is then shared with the fungus.

91. (4) Monera
In the five-kingdom classification system proposed by Whittaker, the kingdom Monera is designed to include all prokaryotic organisms. This group encompasses a wide variety of life forms, including the ancient archaebacteria and various types of eubacteria. Among these are organisms capable of fixing atmospheric nitrogen, such as Rhizobium and cyanobacteria. All these organisms lack a defined nucleus and membrane-bound organelles.

92. (1) the ability to survive during adverse physical conditions
Encystment is a survival mechanism used by Amoeba when environmental conditions become unfavorable. During this process, the organism withdraws its pseudopodia and secretes a protective, three-layered hard shell or cyst around itself. This state allows the Amoeba to survive extreme temperatures, desiccation, and other adverse physical conditions. When favorable conditions return, the organism can emerge from the cyst to resume its normal life activities.

93. (3) Viruses are obligate parasites.
Viruses are unique biological entities that occupy the border between living and non-living things. One of their most significant characteristics is that they are obligate parasites, meaning they can only replicate within a living host cell. They

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lack their own metabolic machinery and must hijack the host's system to reproduce. Each virus contains only one type of nucleic acid, either DNA or RNA.

94. (3) 300 x 20 nm.
Tobacco mosaic virus is a well-studied plant virus that has a distinctive rod-shaped or tubular appearance. The physical dimensions of this virus particle are approximately three hundred nanometers in length and twenty nanometers in diameter. It consists of a single-stranded RNA molecule surrounded by a protective protein coat made of numerous subunits. This specific size and shape are characteristic features of the virus.

95. (4) both require the environment of a cell to replicate.
Viruses and isolated chromosomes both lack the necessary metabolic machinery to function or reproduce independently. Neither can perform life processes such as respiration or protein synthesis outside of a living cell. To replicate, both require the complex environment and enzymes provided by a host cell's cytoplasm and nucleus. This shared dependency highlights why viruses are often considered non-living when outside of their hosts.

96. (2) mode of nutrition
The five-kingdom system of classification uses several key criteria to group living organisms. While cell structure and body organization are important, the primary basis for Whittaker's classification is the mode of nutrition. This includes distinguishing between autotrophic producers, heterotrophic consumers that ingest food, and saprophytic decomposers that absorb nutrients. This focus on how organisms obtain energy helps define the major biological kingdoms.

97. (1) Transfer of some genes from one bacteria to another bacteria through virus.
Transduction is a method of horizontal gene transfer in bacteria that involves the movement of DNA from one cell to another. This process is mediated by a virus that infects bacteria, known as a bacteriophage. When the virus replicates in a donor bacterium, it may accidentally package some bacterial DNA, which is then injected into a new recipient bacterium during a subsequent infection.

98. (1) extra chromosomal material
In addition to their main circular chromosome, many bacteria possess smaller, independent molecules of DNA called plasmids. A plasmid is an extra-chromosomal genetic element that can replicate independently of the main bacterial DNA. Plasmids often carry genes that provide specific advantages to the bacteria, such as antibiotic resistance or the ability to perform conjugation, but they are not part of the core genome.

99. (2) chemoautotrophs
Organisms are classified by their energy and carbon sources. Chemoautotrophs are a group of bacteria that obtain energy by the oxidation of reduced inorganic compounds, such as ammonia, nitrites, or hydrogen sulfide. They use this energy to fix carbon dioxide and produce organic molecules. Unlike photoautotrophs, they do not require sunlight for their metabolism and can thrive in dark or extreme environments.

100. (4) Paramecium caudatum
Nuclear dimorphism is a unique characteristic found in certain groups of protozoans, most notably the ciliates. Paramecium caudatum is a classic example that possesses two distinct types of nuclei within a single cell. The large macronucleus manages the cell's daily metabolic activities and growth. The smaller micronucleus contains the genetic information and is primarily involved in sexual reproduction through the process of conjugation.

101. (1) contractile vacuole
In single-celled protozoa like Amoeba and Paramecium, the contractile vacuole serves a vital physiological role known as osmoregulation. Because these organisms often live in freshwater environments, water constantly enters their cells through the process of osmosis. The contractile vacuole actively collects this excess water from the cytoplasm and periodically contracts to pump it out of the cell. This process prevents the organism from swelling and eventually bursting due to water intake.

102. (1) Loose smut of wheat
Certain fungal diseases are particularly difficult to control because the pathogen is carried within the plant's own tissues or reproductive parts. Loose smut of wheat, caused by Ustilago tritici, is an example of an internally seed-borne disease.

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The fungus infects the developing grain and remains dormant until the next season. When the seed grows, the fungus spreads through the flowers, replacing grains with spores.

103. (1) Aspergillus
During the storage of crop plants, specific fungi can grow on the harvested material and produce dangerous secondary metabolites known as mycotoxins. Aspergillus is a common genus that thrives in these conditions, particularly on damp grains and nuts. Some species produce aflatoxins, which are highly toxic and carcinogenic to humans and animals. Proper storage conditions are essential to prevent the growth of these fungi.

104. (4) Oldest living beings
Archaebacteria represent a group of primitive prokaryotes that are considered some of the oldest living beings on Earth. They are distinguished by their ability to survive in extreme environments that resemble conditions on the early planet, such as high heat, acidity, or salinity. Their unique cell wall and membrane structures differentiate them from eubacteria and highlight their ancient evolutionary lineage within biological classification.

105. (1) cell wall
The Gram staining technique is a fundamental tool in microbiology used to classify bacteria into two major groups. The difference between Gram-positive and Gram-negative bacteria is primarily due to the composition and structure of their cell walls. Gram-positive bacteria have a thick layer of peptidoglycan that retains the crystal violet stain. Gram-negative bacteria have a thinner peptidoglycan layer and an additional outer membrane.

106. (3) ds DNA.
While most viruses that infect plants use single-stranded RNA as their genetic material, there are notable exceptions. The cauliflower mosaic virus is a well-known example that contains double-stranded DNA. This virus infects a variety of plants in the cabbage family. Its unique genome organization and replication cycle make it an important subject in plant virology and a useful tool in plant biotechnology and research.

107. (1) Puccinia
Black rust of wheat is a significant agricultural disease that affects the stems and leaves of cereal crops. This fungal infection is caused by the pathogen Puccinia graminis. It is a heteroecious fungus, meaning it requires two different hosts to complete its life cycle. The disease leads to reduced grain yield and quality. Control measures often involve developing resistant varieties and managing the alternate host plants.

108. (3) Rhizopus
Fungi produce various specialized structures within their reproductive organs to facilitate spore development. In the genus Rhizopus, the sporangium contains a central, sterile, dome-shaped structure known as the columella. This structure supports the spore-producing part of the sporangium and plays a role in the dispersal of spores when the outer wall of the sporangium ruptures. This feature is characteristic of many zygomycete fungi.

109. (3) Monera
The five-kingdom system of classification groups organisms based on their cellular organization and other traits. Kingdom Monera was specifically created to include all prokaryotic life forms. This diverse kingdom encompasses blue-green algae, various nitrogen-fixing bacteria, and ancient methanogenic archaebacteria. All these organisms share the common feature of lacking a membrane-bound nucleus and specialized organelles, distinguishing them from the eukaryotes in the other four kingdoms.

110. (1) bacteriophages released from the donor bacterial strain
Transduction is a biological process through which genetic material is transferred from a donor bacterium to a recipient bacterium. This transfer is mediated by bacteriophages, which are viruses that infect bacteria. When these viruses are released from a donor strain, they may carry pieces of the donor's DNA. This DNA is then introduced into a new bacterial cell when the virus infects another host.

111. (2) 32×10^5 cells
Bacterial growth can be calculated based on the number of generations that occur over a specific period. If a bacterium divides every thirty-five minutes, it will undergo five divisions in one hundred and seventy-five minutes. Starting with one hundred thousand cells, the population doubles with each generation. After five doublings, the final concentration will be

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thirty-two times the initial amount, resulting in 3.2 million cells.

112. (2) double stranded and circular
Escherichia coli is a well-studied bacterium that serves as a model organism in molecular biology. Its genetic material consists of a single, double-stranded DNA molecule that is arranged in a circular form. This circular chromosome is located in the nucleoid region of the cytoplasm. Unlike eukaryotic DNA, it is not associated with histone proteins and is not enclosed within a membrane-bound nucleus.

113. (2) digestion or breakdown of organic compounds
Bacteria play a fundamental role in the global carbon cycle through their metabolic activities. Their primary contribution involves the decomposition or breakdown of complex organic compounds found in dead plants and animals. By breaking down these materials, bacteria release carbon dioxide back into the atmosphere and return essential nutrients to the soil. This process ensures that carbon is continuously recycled and made available for other organisms.

114. (4) marine archaebacteria.
Certain organisms, known as hyperthermophiles, are uniquely adapted to thrive at temperatures exceeding one hundred degrees Celsius. These specialized life forms are often found in extreme marine environments, such as deep-sea hydrothermal vents. Many of these organisms are classified as marine archaebacteria. Their proteins and membranes are exceptionally stable, allowing them to maintain cellular functions in conditions that would be lethal to almost all other known life forms.

115. (1) telia on wheat leaves
Puccinia graminis is a complex fungus that produces several different types of spores on different hosts during its life cycle. On the primary host, which is the wheat plant, the fungus produces two types of spores: uredospores and teleutospores. These spores are formed in structures called uredia and telia, respectively. The other stages of its life cycle, involving pycnia and aecia, occur on the alternate host, the barberry plant.

116. (2) double-stranded DNA
The hereditary material in the bacterium Escherichia coli is composed of double-stranded DNA. This genetic information is organized into a single circular chromosome that contains all the essential genes for the organism's survival and reproduction. This DNA is not enclosed in a nuclear membrane, which is a characteristic feature of prokaryotes. While bacteria also contain RNA, it serves primarily in protein synthesis and gene regulation.

117. (3) either DNA or RNA
Viruses are simple infectious entities that consist of a genetic core surrounded by a protective protein coat. One of their defining biological features is that they contain only one type of nucleic acid, which can be either DNA or RNA. They lack cellular structures such as ribosomes or other organelles required for metabolism. Consequently, they must rely entirely on the machinery of a host cell to replicate.

118. (1) green algae and ascomycetes
Lichens are symbiotic associations formed between a photosynthetic partner and a fungal partner. In the majority of lichens, the photosynthetic component is a green alga, and the fungal component belongs to the class Ascomycetes. The alga provides food through photosynthesis, while the fungus offers structural support and protection. This partnership allows lichens to colonize various environments where neither the alga nor the fungus could survive alone.

119. (2) Prokaryotes
Blue-green algae, also known as cyanobacteria, are a group of photosynthetic organisms that are classified as prokaryotes. Despite their name, they are true bacteria and belong to the Kingdom Monera. They lack a defined nucleus and membrane-bound organelles, which distinguishes them from eukaryotic algae and plants. Cyanobacteria play a critical role in Earth's history by producing oxygen and fixing atmospheric nitrogen in various ecosystems.

120. (4) non-symbiotic N_2 fixer.
Nitrogen fixation is an essential process carried out by specific bacteria in the soil. Genera such as Azotobacter and Bacillus polymyxa are notable examples of non-symbiotic nitrogen fixers. These organisms live freely in the soil and do not require a host plant to perform nitrogen fixation. They convert atmospheric nitrogen into forms that can be utilized by plants, thereby

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significantly contributing to soil fertility and the nitrogen cycle.

121. (1) Sex pili
Some bacteria possess specialized surface structures called sex pili, which are used during a process of genetic exchange known as conjugation. These long, tubular appendages allow a donor bacterium to attach to a recipient bacterium. Once attached, the pili facilitate the transfer of genetic material, such as plasmids, between the two cells. This mechanism allows bacteria to share beneficial traits, including antibiotic resistance, across a population.

122. (1) Circular free DNA
Bacterial genetic material is characterized by a specific organization that differs from that of eukaryotes. In bacteria, the DNA is typically arranged as a single, double-stranded circular molecule. This circular DNA is free-floating within the cytoplasm in a region called the nucleoid, as it is not enclosed by a nuclear membrane. This arrangement allows for efficient replication and gene expression within the simple cellular structure of prokaryotes.

123. (2) symbiotic relationship between fungi and roots of some higher plants
Mycorrhiza is a beneficial biological association that occurs between certain types of fungi and the roots of many higher plants. This relationship is correctly described as symbiotic because both partners derive significant advantages. The fungus helps the plant absorb essential nutrients like phosphorus from the soil more efficiently. In return, the plant provides the fungus with organic food produced through photosynthesis, supporting its growth and metabolism.

124. (2) RNA
The influenza virus is a significant human pathogen that causes seasonal respiratory illness. Like many animal viruses, its genetic material is composed of RNA rather than DNA. This RNA genome is segmented, which allows the virus to undergo rapid genetic changes through a process called reassortment. This variability is the reason why new flu vaccines must be developed frequently to match the circulating strains of the virus.

125. (1) These grow very rapidly (2 cm per day).
Lichens are unique organisms that grow extremely slowly, often increasing in size by only a few millimeters each year. They are well known for their symbiotic relationship between fungi and algae. Some species serve as an important food source for animals like reindeers. Furthermore, lichens are highly sensitive to air quality and are widely used as natural indicators of sulfur dioxide pollution in the environment.

126. (4) Pseudomonas.
The genus Pseudomonas includes a diverse group of bacteria known for their remarkable metabolic capabilities. These bacteria are able to utilize a wide range of organic compounds as energy sources, allowing them to decompose complex materials in many different environments. This metabolic flexibility makes them important decomposers in nature and useful in bioremediation processes to break down pollutants, including various hydrocarbons and other synthetic organic chemicals.

127. (1) Euglena
Euglena is a unique unicellular organism that displays characteristics of both plants and animals. Like plants, it contains chloroplasts and can perform photosynthesis when light is available. However, in the absence of light, it can act like an animal by consuming other small organisms for food. It also possesses a flagellum for movement and lacks a rigid cell wall, reflecting its dual nature in biological classification.

128. (1) osmoregulation
In single-celled protozoa, the contractile vacuole serves a vital physiological role known as osmoregulation. Because these organisms often live in freshwater environments, water constantly enters their cells through the process of osmosis. The contractile vacuole actively collects this excess water from the cytoplasm and periodically contracts to pump it out of the cell. This process prevents the organism from swelling and eventually bursting due to water intake.

129. (2) Puccinia graminis tritici
Black rust of wheat is a devastating fungal disease that impacts grain production worldwide. The pathogen responsible for this infection is Puccinia graminis tritici. This fungus is specialized to infect wheat plants, where it forms characteristic dark, rust-colored pustules on

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the stems and leaves. It follows a complex life cycle that involves different types of spores and requires an alternate host plant, the barberry, to complete its development.

130. (2) non-motile
Tailed bacteriophages are a specific group of viruses that possess a head containing genetic material and a complex tail structure used for infecting bacteria. Despite their structural complexity, these viruses are non-motile. They do not have the ability to move independently through water or on surfaces. Instead, they rely on passive collision with their host bacterial cells, which occurs through brownian motion or environmental movement in their surroundings.

131. (2) importance of homopolar bonds in their proteins
Many blue-green algae, or cyanobacteria, are capable of surviving in extreme environments like thermal springs where temperatures are very high. Their remarkable temperature tolerance is largely attributed to the stable structure of their proteins. Specifically, the presence of strong homopolar bonds within their proteins helps maintain their shape and function even at high heat. This prevents the denaturation of vital enzymes, allowing the algae to remain metabolically active.

132. (1) bacteria
Nitrogen fixation is a critical process that converts atmospheric nitrogen into a form that plants can use. This important biological function is primarily carried out by certain types of bacteria found in the soil. These organisms can be free-living, such as Azotobacter, or exist in symbiotic relationships with plants, such as Rhizobium. By enriching the soil with nitrogen, these bacteria play a vital role in maintaining ecosystem productivity and fertility.

133. (2) phage vectors
Transduction is a specialized mechanism for the transfer of genetic information between bacterial cells. This process is mediated by phage vectors, which are viruses that infect bacteria. When a bacteriophage replicates inside a host cell, it may occasionally package fragments of the host's DNA. This genetic material is then carried by the virus and injected into a different bacterium during a subsequent infection, leading to genetic recombination in the recipient.

134. (2) membrane bound nucleoproteins lying embedded in the cytoplasm
Protists are defined as a kingdom of unicellular eukaryotic organisms. Unlike prokaryotes, their cells contain a well-defined, membrane-bound nucleus that encloses their genetic material. This nuclear organization consists of nucleoproteins, such as DNA associated with proteins, lying embedded within the cytoplasm. This structural arrangement ensures that the genetic information is separated from the rest of the cellular contents, allowing for more complex regulation of cellular processes and gene expression.

135. (1) single stranded RNA
Tobacco mosaic virus is a classic rod-shaped virus that infects a wide variety of plants, especially tobacco. The genetic material of this virus consists of a single-stranded RNA molecule. This RNA carries the necessary genes for the virus to replicate within its host and produce more viral particles. The RNA is protected by a protein coat called a capsid, which is composed of many identical subunits known as capsomeres.

136. (3) a single double stranded DNA
The genetic material of a bacterium, often referred to as the genophore or nucleoid, is composed of a single, double-stranded circular DNA molecule. Unlike eukaryotic chromosomes, this bacterial genome is not associated with histone proteins and is not enclosed within a nuclear membrane. It contains all the essential genetic information required for the cell's survival, growth, and reproduction. The DNA is condensed through supercoiling to fit within the small bacterial cell.

137. (1) easily cultured
Escherichia coli is one of the most widely used organisms in biological and genetic research. Its popularity stems from the fact that it is easily cultured under laboratory conditions with simple nutrient requirements. Additionally, it has a very short generation time, allowing for rapid multiplication and experiments. Its well-understood genetics and the ease with which it can be handled make it an ideal model organism for studying fundamental biological processes and molecular cloning.

138. (1) neither syngamy nor reduction division
Alternation of generations is a life cycle characteristic of many plants and some algae, involving a regular transition between haploid

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and diploid phases. Bacteria lack this process because they do not undergo true sexual reproduction. Specifically, they do not perform syngamy, which is the fusion of gametes, nor do they undergo reduction division or meiosis. Instead, bacteria reproduce primarily through asexual binary fission, where the genetic material is simply replicated and divided.

139. (2) lichens
Lichens are composite organisms that are highly sensitive to atmospheric conditions, particularly the presence of sulfur dioxide. Because they lack a protective cuticle and absorb water and nutrients directly from the air, high levels of pollutants can easily damage them. This sensitivity makes lichens excellent natural indicators of air pollution. In areas with high sulfur dioxide concentrations, lichens are often absent or show significantly reduced growth and diversity compared to cleaner regions.

140. (2) anatomical and physiological traits
Modern biological classification has evolved to go beyond simple outer appearances. While morphology remains relevant, an important criterion for today's scientists involves examining anatomical and physiological traits. These features provide a deeper understanding of an organism's internal structure and functional mechanisms. By comparing these traits, along with genetic information and evolutionary history, taxonomists can more accurately determine the relationships between different groups of organisms and place them correctly within the tree of life.

141. (1) Chemosynthetic bacteria
Most life on Earth relies on energy from the sun, either directly through photosynthesis or indirectly by consuming photosynthetic organisms. However, chemosynthetic bacteria are unique because they do not derive energy from sunlight. Instead, they obtain energy through the oxidation of inorganic compounds like ammonia or hydrogen sulfide. This allows them to produce organic food and thrive in environments where light is completely absent, such as deep-sea hydrothermal vents or caves.

142. (3) contractile vacuole
In single-celled organisms like Amoeba and Paramecium, maintaining the correct internal water balance is essential for survival. This process, known as osmoregulation, occurs through a specialized organelle called the contractile vacuole. As water enters the cell from the surrounding environment, the vacuole collects it and then contracts to expel the excess water. This mechanism prevents the cell from taking in too much water and bursting, ensuring the organism remains stable in its aquatic habitat.

143. (1) cell wall
The primary distinction between Gram-positive and Gram-negative bacteria is found in the structure and composition of their cell walls. Gram-positive bacteria possess a thick layer of peptidoglycan, which effectively traps the primary stain during the Gram staining process. In contrast, Gram-negative bacteria have a much thinner peptidoglycan layer and an additional outer lipid membrane. These fundamental differences in cell wall architecture influence the bacteria's response to various stains, chemicals, and medical antibiotics.

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144. (2) Escherichia
Kingdom Monera is a group in the five-kingdom classification system that consists entirely of prokaryotic organisms. This kingdom primarily includes bacteria, which lack a defined nucleus and membrane-bound organelles. Escherichia is a well-known genus of bacteria that serves as a classic example of a moneran. In contrast, organisms like Amoeba belong to Kingdom Protista, while Gelidium and Spirogyra are multicellular or colonial eukaryotes that are classified as members of the plant kingdom.

145. (3) sporozoa
Plasmodium is the parasitic organism responsible for causing malaria in humans and other animals. In the classification of protozoans, it is placed in the class Sporozoa. This group is characterized by the production of infectious spore-like stages during their complex life cycles. Unlike other protozoans, members of Sporozoa do not have specialized locomotory structures like flagella or cilia. They are all obligate parasites that live within the cells or tissues of their hosts.

146. (1) Polymorphic
Trypanosoma is a genus of parasitic protozoans that is well known for exhibiting polymorphism. This means that the organism can change its physical form and structure at different stages of its life cycle to adapt to different environments

or hosts. For example, it takes on distinct shapes while living in the bloodstream of a vertebrate host compared to its form within an insect vector. These adaptations are essential for its survival and successful transmission.

147. (1) micronucleus
Paramecium is a ciliate protozoan that exhibits nuclear dimorphism, meaning it contains two different types of nuclei. The small micronucleus is the repository for the organism's genetic information and is primarily involved in sexual reproduction and genetic recombination. In contrast, the large macronucleus controls the cell's daily metabolic activities and physiological functions. This separation of tasks allows the Paramecium to maintain its genetic integrity while efficiently managing its complex cellular processes and growth.

148. (2) fungi
Fungi are a unique kingdom of organisms that obtain their nutrients through a process called absorptive heterotrophic nutrition. Instead of ingesting food like animals or producing it like plants, fungi secrete powerful digestive enzymes directly onto their organic food source. These enzymes break down complex materials into simpler molecules, which are then absorbed through the fungal cell walls. This nutritional strategy allows fungi to function as essential decomposers in various ecosystems by recycling nutrients.

149. (2) Zooflagellata.
Trypanosoma is a genus of unicellular protozoans that are classified within the class Zooflagellata. Members of this group are characterized by the presence of one or more flagella, which they use for movement through their environment. Many zooflagellates are parasitic and cause serious diseases in humans and animals. Trypanosoma species, for instance, are responsible for conditions such as African sleeping sickness and Chagas disease, living primarily as parasites in blood and tissue fluids.

150. (3) are sensitive to SO_2
Lichens are highly sensitive organisms that are often used as natural monitors of air quality. Their sensitivity to air pollution, particularly sulfur dioxide, makes them excellent indicators. Because they lack a protective outer layer and obtain nutrients from rainwater and the atmosphere, they easily accumulate pollutants. In areas with high concentrations of sulfur dioxide, lichens fail to survive or show significantly stunted growth. Therefore, their presence and health are directly related to the local air purity.

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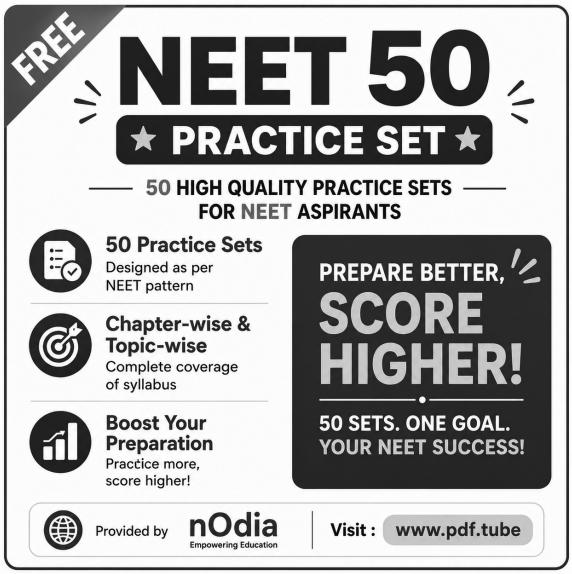

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CHAPTER 03
Plant Kingdom

2026 (RE-NEET)

1. Given below are two statements :
Statement I : In gymnosperms, male and female gametophytes remain within the sporangia.
Statement II: In gymnosperms, seeds are not covered.
In the light of the above statements,choose the most appropriate answer from the options given below :
(1) Statement I is correct but Statement II is incorrect
(2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Both Statement I and Statement II are incorrect

2026 (RE-NEET)

2. Sphenopsida class belongs to:
(1) gymnosperms
(2) pteridophytes
(3) bryophytes
(4) angiosperms

2026 (CANCELLED)

3. In which of the following are the ovules not enclosed by an ovary wall and remain exposed?
(1) Funaria (2) Pinus
(3) Selaginella (4) Wolffia

2025

4. In bryophytes, the gemmae help in which one of the following?
(1) Nutrient absorption
(2) Gaseous exchange
(3) Sexual reproduction
(4) Asexual reproduction

2025

5. The correct sequence of events in the life cycle of bryophytes is
A. Fusion of antherozoid with egg.
B. Attachment of gametophyte to substratum.
C. Reduction division to produce haploid spores.
D. Formation of sporophyte.
E. Release of antherozoids into water.
Choose the correct answer from the options given below:
(1) B, E, A, D, C
(2) D, E, A, B, C
(3) D, E, A, C, B
(4) B, E, A, C, D

2025

6. Given below are the stages in the life cycle of pteridophytes. Arrange the following stages in the correct sequence.
A. Prothallus stage
B. Meiosis in spore mother cells
C. Fertilisation
D. Formation of archegonia and antheridia in gametophyte.
E. Transfer of antherozoids to the archegonia in presence of water.
Choose the correct answer from the options given below.
(1) D, E, C, A, B
(2) E, D, C, B, A
(3) B, A, D, E, C
(4) B, A, E, C, D

NODIA

2025

7. Which one of the following is the characteristic feature of gymnosperms?
(1) Seeds are absent.
(2) Gymnosperms have flowers for reproduction.
(3) Seeds are enclosed in fruits.
(4) Seeds are naked.

2025

8. Match List-I with List-II.

	List-I		List-II
A.	Pteridophyte	I.	Salvia
B.	Bryophyte	II.	Ginkgo
C.	Angiosperm	III.	Polytrichum
D.	Gymnosperm	IV.	Salvinia

Choose the option with all correct matches.
(1) A-III, B-IV, C-I, D-II
(2) A-IV, B-III, C-II, D-I
(3) A-III, B-IV, C-II, D-I
(4) A-IV, B-III, C-I, D-II

2024

9. Read the following statements and choose the set of correct statements.
In the members of Phaeophyceae,
A. a sexual reproduction occurs usually by biflagellate zoospores
B. sexual reproduction is by oogamous method only
C. stored food is in the form of carbohydrates which is either mannitol or laminarin
D. the major pigments found are chlorophyll a, c and carotenoids and xanthophyll
E. vegetative cells have cellulosic wall, usually covered on the outside by gelatinous coating of algin.
Choose the correct answer from the options given below.
(1) A, B, C and D only
(2) B, C, D and E only
(3) A, C, D and E only
(4) A, B, C and E only

RE-EXAM 2024

10. Identify the incorrect pair.
(1) Sphenopsida - Adiantum
(2) Pteropsida - Dryopteris
(3) Psilopsida - Psilotum
(4) Lycopsida - Selaginella

RE-EXAM 2024

11. Which of the following is the correct match?
(1) Gymnosperms - Cedrus, Pinus, Sequoia
(2) Angiosperms - Wolffia, Eucalyptus, Sequoia
(3) Bryophytes - Polytrichum, Polysiphonia, Sphagnum
(4) Pteridophytes - Equisetum, Ginkgo, Adiantum

Manipur NEET 2023

12. Which classes of algae possess pigment fucoxanthin and pigment phycoerythrin, respectively?
(1) Phaeophyceae and Chlorophyceae
(2) Phaeophyceae and Rhodophyceae
(3) Chlorophyceae and Rhodophyceae
(4) Rhodophyceae and Phaeophyceae

2023

13. Given below are two statements :
One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : The first state of gametophyte in the life cycle of moss is protonema stage.
Reason (R) : Protonema develops directly from spores produced in capsule.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) (A) is correct but (R) is not correct.
(2) (A) is not correct but (R) is correct.
(3) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(4) Both (A) and (R) are correct but (R) is not the correct explanation of (A).

Manipur NEET 2023

14. Match List-I with List-II.

	List-I		List-II
A.	Pteropsida	I.	Psilotum
B.	Lycopsida	II.	Equisetum
C.	Psilopsida	III.	Adiantum
D.	Sphenopsida	IV.	Selaginella

Choose the correct answer from the options given below.
(1) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
(2) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(3) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
(4) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)

2023

15. Identify the pair of heterosporous pteridophytes among the following.
(1) Psilotum and Salvinia
(2) Equisetum and Salvinia
(3) Lycopodium and Selaginella
(4) Selaginella and Salvinia

2023

16. Given below are two statements :
One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : In gymnosperms, the pollen grains are released from the microsporangium and carried by air currents.
Reason (R) : Air currents carry the pollen grains to the mouth of the archegonia where the male gametes are discharged and pollen tube is not formed.
In the light of the above statements, choose the correct answer from the options given below :
(1) (A) is true but (R) is false.
(2) (A) is false but R is true.
(3) Both (A) and (R) are true and (R) is the correct explanation of (A).
(4) Both (A) and (R) are true but (R) is not the correct explanation of A.

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Manipur NEET 2023

17. Which of the following statements is true?
(1) All pteridophytes exhibit haplo-diplontic pattern.
(2) Seed bearing plants follow haplontic pattern.
(3) Most algal genera are diplontic.
(4) Most bryophytes do not have haplo-diplontic life cycle.

2022

18. Which of the following is incorrectly matched?
(1) Ectocarpus - Fucoxanthin
(2) Ulothrix - Mannitol
(3) Porphyra - Floridean starch
(4) Volvox - Starch

2022

19. Hydrocolloid carrageen is obtained from
(1) Chlorophyceae and Phaeophyceae
(2) Phaeophyceae and Rhodophyceae
(3) Rhodophyceae only
(4) Phaeophyceae only.

2022

20. Match the plant with the kind of life cycle it exhibits.

	List-I		List-II
(A)	Spirogyra	(i)	Dominant diploid sporophyte, vascular plant, with highly reduced male or female gametophyte
(B)	Fern	(ii)	Dominant haploid free living gametophyte
(C)	Funaria	(iii)	Dominant diploid sporophyte alternating with reduced gametophyte called prothallus
(D)	Cycas	(iv)	Dominant haploid leafy gametophyte alternating partially dependent multicellular sporophyte

Choose the correct answer from the option below:
(1) (A) - (iv), (B) - (i), (C) - (ii), (D) - (iii)
(2) (A) - (ii), (B) - (iii), (C) - (iv), (D) - (i)
(3) (A) - (iii), (B) - (iv), (C) - (i), (D) - (ii)
(4) (A) - (ii), (B) - (iv), (C) - (i), (D) - (iii)

2021

21. Which of the following algae produce Carrageen?
(1) Blue-green algae
(2) Green algae
(3) Brown algae
(4) Red algae

2021

22. Which of the following algae contains mannitol as reserve food material?
(1) Ulothrix
(2) Ectocarpus
(3) Gracilaria
(4) Volvox

2021

23. Gemmae are present in
(1) some liverworts
(2) mosses
(3) pteridophytes
(4) some gymnosperms.

2021

24. Genera like Selaginella and Salvinia produce two kinds of spores. Such plants are known as
(1) heterosporous
(2) homosorus
(3) heterosorus
(4) homosporous.

2021

25. Which of the following plants is monoecious?
(1) Cycas circinalis
(2) Carica papaya
(3) Chara
(4) Marchantia polymorpha

2020

26. Floridean starch has structure similar to
(1) starch and cellulose
(2) amylopectin and glycogen
(3) mannitol and algin
(4) laminarin and cellulose.

NODIA

2020

27. Which of the following pairs is of unicellular algae?
(1) Laminaria and Sargassum
(2) Gelidium and Gracilaria
(3) Anabaena and Volvox
(4) Chlorella and Spirulina

2020

28. Strobili cones are found in
(1) Salvinia
(2) Pteris
(3) Marchantia
(4) Equisetum.

2018

29. Which one is wrongly matched?
(1) Uniflagellate gametes - Polysiphonia
(2) Biflagellate zoospores - Brown algae
(3) Gemma cups - Marchantia
(4) Unicellular organism - Chlorella

2018

30. Which of the following statements is correct?
(1) Ovules are not enclosed by ovary wall in gymnosperms.
(2) Selaginella is heterosporous, while Salvinia is homosporous.
(3) Horsetails are gymnosperms.
(4) Stems are usually unbranched in both Cycas and Cedrus.

2017

31. An example of colonial alga is
(1) Volvox
(2) Ulothrix
(3) Spirogyra
(4) Chlorella.

2017

32. Select the mismatch.
(1) Cycas - Dioecious
(2) Salvinia - Heterosporous
(3) Equisetum - Homosporous
(4) Pinus - Dioecious

2017

33. Zygotic meiosis is characteristic of
(1) Fucus
(2) Funaria
(3) Chlamydomonas
(4) Marchantia.

2017

34. Life cycles of Ectocarpus and Fucus respectively are
(1) diplontic, haplodiplontic
(2) haplodiplontic, diplontic
(3) haplodiplontic, haplontic
(4) haplontic, diplontic.

NEET-II 2016

35. Which one of the following statements is wrong?
(1) Algae increase the level of dissolved oxygen in the immediate environment.
(2) Algin is obtained from red algae, and carrageenan from brown algae.
(3) Agar-agar is obtained from Gelidium and Gracilaria.
(4) Laminaria and Sargassum are used as food.

NEET-I 2016

36. In bryophytes and pteridophytes, transport of male gametes requires
(1) birds (2) water
(3) wind (4) insects.

NEET-II 2016

37. Conifers are adapted to tolerate extreme environmental conditions because of
(1) broad hardy leaves
(2) superficial stomata
(3) thick cuticle
(4) presence of vessels.

NEET-I 2016

38. Select the correct statement.
(1) Sequoia is one of the tallest trees.
(2) The leaves of gymnosperms are not well adapted to extremes of climate.
(3) Gymnosperms are both homosporous and heterosporous.
(4) Salvinia, Ginkgo and Pinus all are gymnosperms.

2015 Cancelled

39. Which one of the following statements is wrong?
(1) Chlorella and Spirulina are used as space food.
(2) Mannitol is stored food in Rhodophyceae.
(3) Algin and carrageenan are products of algae.
(4) Agar-agar is obtained from Gelidium and Gracilaria.

2015 Cancelled

40. Male gametes are flagellated in
(1) Ectocarpus (2) Spirogyra
(3) Polysiphonia (4) Anabaena.

2015 Cancelled

41. In which of the following, gametophyte is not independent free living?
(1) Pteris
(2) Pinus
(3) Funaria
(4) Marchantia

2015 Cancelled

42. Read the following five statements (A to E) and select the option with all correct statements.
A. Mosses and lichens are the first organisms to colonise a bare rock.
B. Selaginella is a homosporous pteridophyte.
C. Coralloid roots in Cycas have VAM.
D. Main plant body in bryophytes is gametophytic, whereas in pteridophytes it is sporophytic.

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E. In gymnosperms, male and female gametophytes are present within sporangia located on sporophyte.
(1) A, D and E
(2) B, C and E
(3) A, C and D
(4) B, C and D

2015

43. Which one is a wrong statement?
(1) Haploid endosperm is typical feature of Gymnosperms.
(2) Brown algae have chlorophyll a and c and fucoxanthin.
(3) Archegonia are found in Bryophyta, Pteridophyta and Gymnosperms.
(4) Mucor has biflagellate zoospores.

2014

44. Which one of the following is wrong about Chara?
(1) Upper oogonium and lower round antheridium
(2) Globule and nucule present on the same plant
(3) Upper antheridium and lower oogonium
(4) Globule is male reproductive structure

2014

45. Which one of the following shows isogamy with non-flagellated gametes?
(1) Sargassum
(2) Ectocarpus
(3) Ulothrix
(4) Spirogyra

2014

46. Which of the following is responsible for peat formation?
(1) Marchantia
(2) Riccia
(3) Funaria
(4) Sphagnum

2013

47. Select the wrong statement.
(1) In oomycetes, female gamete is smaller and motile, while male gamete is larger and non-motile.
(2) Chlamydomonas exhibits both isogamy and anisogamy and Fucus shows oogamy.
(3) Isogametes are similar in structure, function and behaviour.
(4) Anisogametes differ either in structure, function or behaviour.

2013

48. Isogamous condition with non-flagellated gametes is found in
(1) Volvox
(2) Fucus
(3) Chlamydomonas
(4) Spirogyra.

2013

49. Monoecious plant of Chara shows occurrence of
(1) upper antheridium and lower oogonium on the same plant
(2) upper oogonium and lower antheridium on the same plant
(3) antheridiophore and archegoniophore on the same plant
(4) stamen and carpel on the same plant.

Karnataka NEET 2013

50. Which one of the following is wrongly matched?
(1) Spirogyra - Motile gametes
(2) Sargassum - Chlorophyll
(3) Basidiomycetes - Puffballs
(4) Nostoc - Water blooms

Karnataka NEET 2013

51. Syngamy can occur outside the body of the organism in
(1) mosses
(2) algae
(3) ferns
(4) fungi.

Karnataka NEET 2013

52. The plant body is thalloid in
(1) Sphagnum
(2) Salvinia
(3) Marchantia
(4) Funaria.

NODIA

2013

53. Read the following statements (A - E) and answer the question which follows them.
A. In liverworts, mosses and ferns gametophytes are free-living.
B. Gymnosperms and some ferns are heterosporous.
C. Sexual reproduction in Fucus, Volvox and Albugo is oogamous.
D. The sporophyte in liverworts is more elaborate than that in mosses.
E. Both, Pinus and Marchantia are dioecious.
How many of the above statements are correct?
(1) Three (2) Four
(3) One (4) Two

Karnataka NEET 2013

54. What is common in all the three, Funaria, Dryopteris and Ginkgo?
(1) Presence of archegonia
(2) Well developed vascular tissues
(3) Independent gametophyte
(4) Independent sporophyte

2012

55. Which one of the following is common to multicellular fungi, filamentous algae and protonema of mosses?
(1) Diplontic life cycle
(2) Members of Kingdom Plantae
(3) Mode of nutrition
(4) Multiplication by fragmentation

2012

56. Which one of the following is a correct statement?
(1) Pteridophyte gametophyte has a protonemal and leafy stage.
(2) In gymnosperms, female gametophyte is free-living.
(3) Antheridiophores and archegoniophores are present in pteridophytes.
(4) Origin of seed habit can be traced in pteridophytes.

2012

57. Cycas and Adiantum resemble each other in having
(1) seeds
(2) motile sperms
(3) cambium
(4) vessels.

Mains 2012

58. Read the following five statements (A - E) and answer as asked next to them.
A. In Equisetum, the female gametophyte is retained on the parent sporophyte.
B. In Ginkgo, male gametophyte is not independent.
C. The sporophyte in Riccia is more developed than that in Polytrichum.
D. Sexual reproduction in Volvox is isogamous.
E. The spores of slime moulds lack cell walls.
How many of the above statements are correct?
(1) Two (2) Three
(3) Four (4) One

Mains 2012

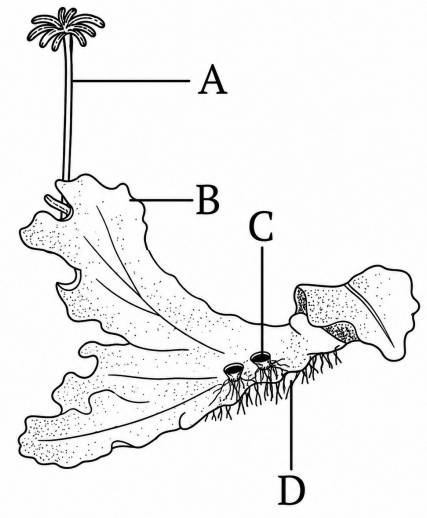
59. Which one of the following pairs is wrongly matched?
(1) Ginkgo - Archegonia
(2) Salvinia - Prothallus
(3) Viroids - RNA
(4) Mustard - Synergids

Mains 2012

60. How many organisms in the list given below are autotrophs?
Lactobacillus, Nostoc, Chara, Nitrosomonas, Nitrobacter, Streptomyces, Saccharomyces, Trypanosoma, Porphyra, Wolffia
(1) Four (2) Five
(3) Six (4) Three

Mains 2011

61. Examine the given figure and select the correct option giving all the four parts (A, B, C and D) rightly identified.



(1) A-Archegoniophore, B-Female thallus, C-Gemma cup, D-Rhizoids
(2) A-Archegoniophore, B-Female thallus, C-Bud, D-Foot
(3) A-Seta, B-Sporophyte, C-Protonema, D-Rhizoids
(4) A-Antheridiophore, B-Male thallus, C-Globule, D-Roots

2011

62. Compared with the gametophytes of the bryophytes, the gametophytes of vascular plants tend to be
(1) smaller but to have larger sex organs
(2) larger but to have smaller sex organs
(3) larger and to have larger sex organs
(4) smaller and to have smaller sex organs.

2011

63. Archegoniophore is present in
(1) Marchantia (2) Chara
(3) Adiantum (4) Funaria.

NODIA

Mains 2011

64. Selaginella and Salvinia are considered to represent a significant step toward evolution of seed habit because
(1) female gametophyte is free and gets dispersed like seeds
(2) female gametophyte lacks archegonia
(3) megaspores possess endosperm and embryo surrounded by seed coat
(4) embryo develops in female gametophyte which is retained on parent sporophyte.

Mains 2011

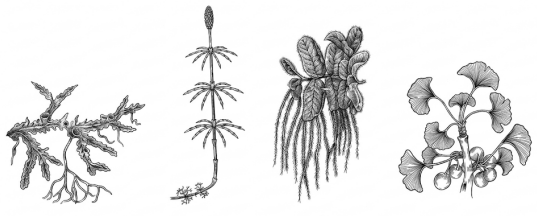
65. Consider the following four statements whether they are correct or wrong.
A. The sporophyte in liverworts is more elaborate than that in mosses.
B. Salvinia is heterosporous.
C. The life-cycle in all seed-bearing plants is diplontic.
D. In Pinus, male and female cones are borne on different trees.
The two wrong statements together are
(1) A and C
(2) A and D
(3) B and C
(4) A and B.

2010

66. Algae have cells made up of
(1) cellulose, galactans and mannans
(2) hemicellulose, pectins and proteins
(3) pectins, cellulose and proteins
(4) cellulose, hemicellulose and pectins.

Mains 2010

67. Examine the figures A, B, C and D. In which one of the four options all the items A, B, C and D are correct?



	A	B	C	D
(1)	Chara	Marchantia	Fucus	Pinus
(2)	Equisetum	Ginkgo	Selaginella	Lycopodium
(3)	Selaginella	Equisetum	Salvinia	Ginkgo
(4)	Funaria	Adiantum	Salvinia	Riccia

2010

68. Male and female gametophytes are independent and free-living in
(1) mustard
(2) castor
(3) Pinus
(4) Sphagnum.

2009

69. Phylogenetic system of classification is based on
(1) morphological features
(2) chemical constituents
(3) floral characters
(4) evolutionary relationships.

2009

70. Mannitol is the stored food in
(1) Porphyra
(2) Fucus
(3) Gracilaria
(4) Chara.

2009

71. Which one of the following is considered important in the development of seed habit?
(1) Heterospory
(2) Haplontic life cycle
(3) Free-living gametophyte
(4) Dependent sporophyte

2009

72. Which one of the following is a vascular cryptogam?
(1) Ginkgo (2) Marchantia
(3) Cedrus (4) Equisetum

2009

73. Which one of the following has haplontic life cycle?
(1) Polytrichum (2) Ustilago
(3) Wheat (4) Funaria

2008

74. Which one of the following is heterosporous?
(1) Adiantum
(2) Equisetum
(3) Dryopteris
(4) Salvinia

2008

75. In which one of the following male and female gametophytes do not have free living independent existence?
(1) Polytrichum
(2) Cedrus
(3) Pteris
(4) Funaria

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2008

76. Select one of the following pairs of important features distinguishing Gnetum from Cycas and Pinus and showing affinities with angiosperms.
(1) Perianth and two integuments
(2) Embryo development and apical meristem
(3) Absence of resin duct and leaf venation
(4) Presence of vessel elements and absence of archegonia

2007

77. If you are asked to classify the various algae into distinct groups, which of the following characters you should choose?
(1) Nature of stored food materials in the cell
(2) Structural organization of thallus
(3) Chemical composition of the cell wall
(4) Types of pigments present in the cell

2007

78. Spore dissemination in some liverworts is aided by
(1) indusium
(2) calyptra
(3) peristome teeth
(4) elaters.

2007

79. In the prothallus of a vascular cryptogam, the antherozoids and eggs mature at different times. As a result
(1) there is high degree of sterility
(2) one can conclude that the plant is apomictic
(3) self fertilization is prevented
(4) there is no change in success rate of fertilization.

2007

80. In gymnosperms, the pollen chamber represents
(1) a cavity in the ovule in which pollen grains are stored after pollination
(2) an opening in the megagametophyte through which the pollen tube approaches the egg
(3) the microsporangium in which pollen grains develop
(4) a cell in the pollen grain in which the sperms are formed.

2007

81. Flagellated male gametes are present in all the three of which one of the following sets?
(1) Zygnema, Saprolegnia and Hydrilla
(2) Fucus, Marsilea and Calotropis
(3) Riccia, Dryopteris and Cycas
(4) Anthoceros, Funaria and Spirogyra

2006

82. Peat moss is used as a packing material for sending flowers and live plants to distant places because
(1) it serves as a disinfectant
(2) it is easily available
(3) it is hygroscopic
(4) it reduces transpiration.

2006

83. In a moss, the sporophyte
(1) manufactures food for itself, as well as for the gametophyte
(2) is partially parasitic on the gametophyte
(3) produces gametes that give rise to the gametophyte
(4) arises from a spore produced from the gametophyte.

2006

84. Conifers differ from grasses in the
(1) formation of endosperm before fertilization
(2) production of seeds from ovules
(3) lack of xylem tracheids
(4) absence of pollen tubes.

2005

85. Ectophloic siphonostele is found in
(1) Osmunda and Equisetum
(2) Marsilea and Botrychium
(3) Adiantum and Cucurbitaceae
(4) Dicksonia and Maiden hair fern.

2005

86. Match items in column I with those in column II.

NODIA

	Column I		Column II
A.	Peritrichous flagellation	J.	Ginkgo
B.	Living fossil	K.	Macrocystis
C.	Rhizophore	L.	Escherichia coli
D.	Smallest flowering plant	M.	Selaginella
R.	Largest perennial alga	N.	Wolffia

Select the correct answer from the following.
(1) A - L; B - J; C - M; D - N; E - K
(2) A - K; B - J; C - L; D - M; E - N
(3) A - N; B - L; C - K; D - M; E - J
(4) A - J; B - K; C - N; D - L; E - M

2005

87. Top-shaped multiciliate male gametes and the mature seed which bears only one embryo with two cotyledons, are characterised features of

(1) cycads
(2) conifers
(3) polypetalous angiosperms
(4) gamopetalous angiosperms.

2004, 2003

88. Phenetic classification of organisms is based on
(1) observable characteristics of existing organisms
(2) the ancestral lineage of existing organisms
(3) dendrogram based on DNA characteristics
(4) sexual characteristics.

2004

89. Which one of the following is a living fossil?
(1) Cycas (2) Moss
(3) Saccharomyces (4) Spirogyra

2004

90. Angiosperms have dominated the land flora primarily because of their
(1) power of adaptability in diverse habitat
(2) property of producing large number of seeds
(3) nature of self pollination
(4) domestication by man.

2003

91. Sexual reproduction in Spirogyra is an advanced feature because it shows
(1) different sizes of motile sex organs
(2) same size of motile sex organs
(3) morphologically different sex organs
(4) physiologically differentiated sex organs.

2003

92. Plants reproducing by spores such as mosses and ferns are grouped under the general term
(1) cryptogams (2) bryophytes
(3) sporophytes (4) thallophytes.

2003

93. Which one of the following pairs of plants are not seed producers?
(1) Fern and Funaria
(2) Funaria and Ficus
(3) Ficus and Chlamydomonas
(4) Funaria and Pinus

2003

94. Which one of the following is categorised under living fossils?
(1) Pinus
(2) Cycas
(3) Selaginella
(4) Metasequoia

2003

95. Which one pair of examples will correctly represent the grouping spermatophyta according to one of the schemes of classifying plants?
(1) Acacia, sugarcane
(2) Pinus, Cycas
(3) Rhizopus, Triticum
(4) Ginkgo, Pisum

2002

96. Which of the following is without exception in angiosperms?
(1) Presence of vessels
(2) Double fertilisation
(3) Secondary growth
(4) Autotrophic nutrition

2002

97. Which of the following plants produces seeds but not flowers?
(1) Maize
(2) Mint
(3) Peepal
(4) Pinus

2001

98. Cycas has two cotyledons but not included in angiosperms because of
(1) naked ovules
(2) seems like monocot
(3) circinate ptyxis
(4) compound leaves.

2000

99. A student observed an algae with chlorophyll a, d and phycoerythrin, it should belong to
(1) Phaeophyta
(2) Rhodophyta
(3) Chlorophyta
(4) Bacillariophyta.

2000

100. In ferns, meiosis takes place at the time of
(1) spore formation
(2) spore germination
(3) gamete formation
(4) antheridia and archegonia formation.

2000

101. Plant group with largest ovule, largest tree and largest gametes is
(1) gymnosperm
(2) angiosperm
(3) bryophyta
(4) pteridophyta.

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1999

102. A system of classification, in which a large number of traits are considered, is
(1) natural system
(2) phylogenetic system
(3) artificial system
(4) synthetic system.

1999

103. The antherozoids of Funaria are
(1) multiciliated
(2) monociliated
(3) aciliated
(4) biciliated.

1999

104. Bryophytes comprise
(1) dominant phase of gametophyte which produces spores
(2) small sporophyte phase and generally parasitic on gametophyte
(3) sporophyte is of longer duration
(4) dominant phase of sporophyte which is parasitic.

1999

105. Which of the following is true about bryophytes?
(1) They are thalloid.
(2) They posses archegonia.
(3) They contain chloroplast.
(4) All of these

1999

106. Dichotomous branching is found in
(1) liverworts
(2) pteridophytes
(3) fern
(4) Funaria.

1999

107. In which of the following would you place the plants having vascular tissue lacking seeds?
(1) Pteridophytes
(2) Gymnosperms
(3) Algae
(4) Bryophytes

1999

108. The endosperm of gymnosperm is
(1) diploid (2) polyploid
(3) triploid (4) haploid.

1998

109. Ulothrix can be described as a
(1) filamentous alga lacking flagellated reproductive stages
(2) membranous alga producing zoospores
(3) filamentous alga with flagellated reproductive stages
(4) non-motile colonial alga lacking zoospores.

1998

110. Bryophytes are dependent on water, because
(1) water is essential for their vegetative propagation
(2) the sperms can easily reach upto egg in the archegonium
(3) archegonium has to remain filled with water for fertilization
(4) water is essential for fertilization for their homosporous nature.

1998

111. The walking fern is so named because
(1) it propagates vegetatively by its leaf tips
(2) it knows how to walk by itself
(3) its spores are able to walk
(4) it is dispersed through the agency of walking animals.

1998

112. Which one of the following statements about Cycas is incorrect?
(1) It has circinate vernation.
(2) Its xylem is mainly composed of xylem vessel.
(3) Its roots contain some blue-green algae.
(4) It does not have a well organized female flower.

NODIA

1998

113. Transfusion tissue is present in the leaves of
(1) Pinus
(2) Dryopteris
(3) Cycas
(4) both (1) and (3).

1998

114. Largest sperms in the plants world are found in
(1) Banyan
(2) Cycas
(3) Thuja
(4) Pinus.

1997

115. An alga, very rich in protein, is
(1) Chlorella
(2) Nostoc
(3) Spirogyra
(4) Ulothrix.

1997

116. Ulothrix filaments produce
(1) heterogametes
(2) basidiospores
(3) isogametes
(4) anisogametes.

1997

117. Brown algae is characterised by the presence of
(1) fucoxanthin
(2) haematochrome
(3) phycocyanin
(4) phycoerythrin.

1997

118. Bryophytes can be separated from algae, because they
(1) possess archegonia
(2) contain chloroplast
(3) are thalloid forms
(4) have no conducting tissue.

1997

119. Heterospory and seed habit are often exhibited by a plant possessing
(1) petiole
(2) ligule
(3) bract
(4) spathe.

1997

120. Multicellular branched rhizoids and leafy gametophytes are the characteristics of
(1) some bryophytes
(2) pteridophytes
(3) all bryophytes
(4) gymnosperms.

1996

121. Elater mechanism for spore dispersal is exhibited by
(1) liverworts
(2) Marchantia
(3) Riccia
(4) Funaria.

1996

122. Which of the following plant kingdom is called 'amphibians'?
(1) Pteridophyta
(2) Thallophyta
(3) Tracheophyta
(4) Bryophyta

1996

123. The smallest plant family 'Gymnosperm' has how many species?
(1) 640
(2) 300
(3) 1000
(4) 900

1996

124. A gymnospermic leaf carries 16 chromosomes. The number of chromosomes in its endosperm will be
(1) 12
(2) 8
(3) 16
(4) 24.

1995

125. The pyrenoids are made up of
(1) proteinaceous centre and starchy sheath
(2) core of nucleic acid surrounded by protein sheath
(3) core of protein surrounded by fatty sheath
(4) core of starch surrounded by sheath of protein.

1995

126. The plant body of moss (Funaria) is
(1) completely sporophyte
(2) predominantly gametophyte with sporophyte
(3) completely gametophyte
(4) predominantly sporophyte with gametophyte.

1995

127. A well developed archegonium with neck consisting of 4-6 rows and neck canal cells, characterises
(1) gymnosperms and flowering plants
(2) pteridophytes and gymnosperms
(3) gymnosperms only
(4) bryophytes and pteridophytes.

1994

128. Phylogenetic classification is one which is based on
(1) overall similarities
(2) utilitarian system
(3) habits of plants
(4) common evolutionary descent.

1994

129. In Chlorophyceae, the mode of sexual reproduction is
(1) isogamy
(2) anisogamy
(3) oogamy
(4) all of these.

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1994

130. In bryophytes
(1) both generations are independent
(2) gametophytes are dependent upon sporophytes
(3) sporophytes complete their life cycle
(4) sporophytes are dependent upon gametophytes.

1994

131. In Pinus, the wings of the seed develops from
(1) ovuliferous scale
(2) integument
(3) nucellus
(4) bract.

1993

132. Pyrenoids are the centres for formation of
(1) Porphyra
(2) enzymes
(3) fat
(4) starch.

1993

133. Chloroplast of Chlamydomonas is
(1) stellate
(2) cup-shaped
(3) collar-shaped
(4) spiral.

1993

134. In Ulothrix/Spirogyra, reduction division (meiosis) occurs at the time of
(1) gamete formation
(2) zoospore formation
(3) zygospore germination
(4) vegetative reproduction.

1993, 1990

135. Protonema occurs in the life cycle of
(1) Riccia
(2) Funaria
(3) Anthoceros
(4) Spirogyra.

1993

136. Pteridophytes differ from bryophytes and thallophytes in having
(1) vascular tissues
(2) motile antherozoids
(3) archegonia
(4) alternation of generations.

1993

137. Pteridophytes differ from mosses/bryophytes in possessing
(1) independent gametophyte
(2) well developed vascular system
(3) archegonia
(4) flagellate spermatozoids.

1993

138. Which one is the most advanced from evolutionary view point?
(1) Selaginella
(2) Funaria
(3) Chlamydomonas
(4) Pinus

1993

139. Pinus differs from mango in having
(1) tree habit
(2) green leaves
(3) ovules not enclosed in ovary
(4) wood.

1992

140. Which one of the following is not common between Funaria and Selaginella?
(1) Archegonium
(2) Embryo
(3) Flagellate sperms
(4) Roots

NODIA

1992

141. The plant group that produces spores and embryo but lacks vascular tissues and seeds is
(1) Pteridophyta
(2) Rhodophyta
(3) Bryophyta
(4) Phaeophyta.

1992

142. Resin and turpentine are obtained from
(1) Cycas
(2) Pinus
(3) Cedrus
(4) Abies.

1992

143. In Pinus, the pollen grain has 6 chromosomes then in its endosperm will have
(1) 12
(2) 18
(3) 6
(4) 24.

1992

144. A plant having seeds but lacking flowers and fruits belongs to
(1) pteridophytes
(2) mosses
(3) ferns

(4) gymnosperms.

1992

145. A plant in which sporophytic generation is represented by zygote is
(1) Pinus
(2) Selaginella
(3) Chlamydomonas
(4) Dryopteris.

1992

146. Turpentine is got from
(1) angiospermous wood
(2) bryophytes
(3) gymnospermous wood
(4) ferns.

1991

147. The common mode of sexual reproduction in Chlamydomonas is
(1) isogamous
(2) anisogamous
(3) oogamous
(4) hologamous.

1991

148. The product of conjugation in Spirogyra or fertilization of Chlamydomonas is
(1) zygospore
(2) zoospore
(3) oospore
(4) carpospore.

1991

149. Bryophytes are amphibians because
(1) they require a layer of water for carrying out sexual reproduction
(2) they occur in damp places
(3) they are mostly aquatic
(4) all the above.

1991

150. Which one has the largest gametophyte?
(1) Cycas
(2) Angiosperm
(3) Selaginella
(4) Moss

1990

151. Moss peristome takes part in
(1) spore dispersal
(2) photosynthesis
(3) protection
(4) absorption.

1990

152. Apophysis in the capsule of Funaria is
(1) lower part
(2) upper part
(3) middle part
(4) fertile part.

1989

153. System of classification used by Linnaeus was
(1) natural system
(2) artificial system
(3) phylogenetic system
(4) asexual system.

1989

154. Artificial system of classification was first used by
(1) Linnaeus
(2) De Candolle
(3) Pliny the Edler
(4) Bentham and Hooker.

1989

155. Sperms of both Funaria and Pteris were released together near the archegonia of Pteris. Only its sperms enter the archegonia as
(1) Pteris archegonia repel Funaria sperms
(2) Funaria sperms get killed by Pteris sperms
(3) Funaria sperms are less mobile
(4) Pteris archegonia release chemical to attract its sperms.

1989

156. Evolutionary important character of Selaginella is
(1) heterosporous nature
(2) rhizophore
(3) strobili
(4) ligule.

1989

157. In Pinus/gymnosperms, the haploid structure are
(1) megaspore, endosperm and embryo
(2) megaspore, pollen grain and endosperm
(3) megaspore, integument and root
(4) pollen grain, leaf and root.

1988

158. Classification given by Bentham and Hooker is
(1) artificial
(2) natural
(3) phylogenetic
(4) numerical.

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1988

159. Sexual reproduction involving fusion of two cells in Chlamydomonas is
(1) isogamy
(2) homogamy
(3) somatogamy
(4) hologamy.

1988

160. In Pinus/Cycas/gymnosperms, the endosperm is
(1) triploid
(2) haploid
(3) diploid
(4) tetraploid.

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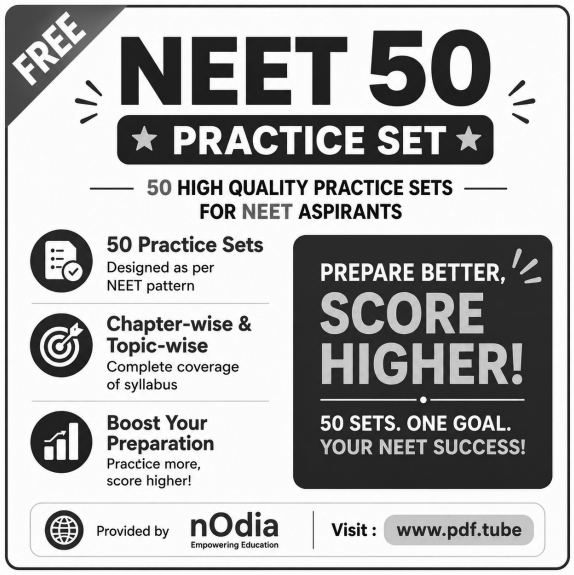

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ANSWERS

1. (3) Both Statement I and Statement II are correct
In gymnosperms the gametophytes are not free-living and remain enclosed within the sporangia on the sporophyte. Also, gymnosperm ovules are not enclosed by an ovary, so the seeds are naked (uncovered). Hence both statements are correct.

2. (2) pteridophytes
Sphenopsida (Equisetopsida), which includes plants like Equisetum (horsetail), is a class belonging to the pteridophytes. Pteridophytes are vascular cryptogams that reproduce by spores and have well-differentiated plant bodies.

3. (2) Pinus
Pinus is a gymnosperm, where ovules are naked and borne exposed on the surface of megasporophylls without an enclosing ovary wall. Funaria is a moss, Selaginella a pteridophyte (both seedless), and Wolffia is an angiosperm having enclosed ovules within an ovary.

4. (4) Asexual reproduction
Gemmae are specialized multicellular asexual buds found in certain liverworts. These green, multicellular structures develop within small receptacles called gemma cups located on the dorsal surface of the thallus. Upon detachment from the parent body, they germinate to produce new individual plants. This process ensures efficient propagation without the involvement of gametic fusion.

5. (1) B, E, A, D, C
The life cycle begins with the attachment of the gametophyte to a suitable substratum. Antherozoids are then released into water to facilitate movement toward the female organ. Following this, the fusion of antherozoid with the egg occurs, resulting in a zygote. This zygote develops into a sporophyte, which eventually undergoes reduction division to produce spores.

6. (3) B, A, D, E, C
The process starts with meiosis occurring in spore mother cells within the sporangia to produce haploid spores. These spores germinate to form a heart-shaped prothallus. The gametophyte then develops archegonia and antheridia. Antherozoids are transferred to the archegonia using water as a medium. Finally, fertilisation takes place to form a diploid zygote for the next generation.

7. (4) Seeds are naked.
Gymnosperms are characterized by the presence of ovules that are not enclosed within an ovary wall. Because the ovules remain exposed both before and after fertilization, the resulting seeds are not covered by a fruit wall. This unique feature distinguishes them from angiosperms. These plants typically possess well-adapted vascular tissues and produce cones for their reproductive processes.

8. (4) A-IV, B-III, C-I, D-II
Pteridophytes like Salvinia are heterosporous plants often found in aquatic habitats. Bryophytes include mosses such as Polytrichum, which exhibit a dominant gametophytic phase. Angiosperms are represented by flowering plants like Salvia, known for their specialized pollination mechanisms. Gymnosperms include Ginkgo, a living fossil characterized by naked seeds and a distinct evolutionary history within the group of seed-bearing plants.

NODIA

9. (3) A, C, D and E only
Brown algae primarily store food as complex carbohydrates like mannitol or laminarin. Their photosynthetic pigments include chlorophyll a, c, carotenoids, and fucoxanthin. The vegetative cells possess a cellulosic wall covered by a gelatinous algin coating. Asexual reproduction typically involves biflagellate zoospores with unequal flagella. However, sexual reproduction can be isogamous, anisogamous, or oogamous, making the oogamous-only claim incorrect.

10. (1) Sphenopsida - Adiantum
Pteridophytes are classified into four distinct classes based on their morphological features. Psilotum belongs to Psilopsida, while Selaginella is a member of Lycopsida. Equisetum is categorized under Sphenopsida. Adiantum and Dryopteris are members of the class Pteropsida, commonly known as ferns. Therefore, pairing

Adiantum with Sphenopsida is scientifically inaccurate as it belongs to a different taxonomic group.

11. (1) Gymnosperms - Cedrus, Pinus, Sequoia
Gymnosperms are seed plants where ovules are not enclosed by an ovary. Representative examples include Cedrus, Pinus, and Sequoia. Bryophytes include mosses like Polytrichum and Sphagnum, but Polysiphonia is a red alga. Pteridophytes encompass Equisetum and Adiantum, while Ginkgo is a gymnosperm. Angiosperms include Wolffia and Eucalyptus, but Sequoia belongs to the gymnosperm group, making other combinations taxonomic mismatches.

12. (2) Phaeophyceae and Rhodophyceae
Different classes of algae are distinguished by their specific photosynthetic pigments. Phaeophyceae, or brown algae, contain the xanthophyll pigment fucoxanthin, which imparts their characteristic brown color. Rhodophyceae, known as red algae, possess the red pigment r-phycoerythrin, allowing them to thrive at greater ocean depths. Chlorophyceae are dominated by chlorophyll a and b, giving them a bright green appearance like land plants.

13. (3) Both (A) and (R) are correct and (R) is the correct explanation of (A).
The life cycle of a moss involves two distinct gametophytic stages. The first stage is the protonema, which develops directly from a haploid spore produced within the capsule of the sporophyte. This filamentous, creeping, and green structure represents the initial phase of the gametophyte. Because the protonema originates from spores, it correctly serves as the primary stage before developing into the leafy gametophyte.

14. (4) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
Pteridophytes are divided into four classes with specific representative genera. Pteropsida includes ferns like Adiantum. Lycopsida is represented by plants such as Selaginella. Psilopsida contains the primitive genus Psilotum. Sphenopsida consists of horsetails like Equisetum. Each class shows unique structural characteristics in their sporophytes. Understanding these taxonomic divisions helps in identifying the evolutionary relationships and morphological diversity found within the various groups of vascular plants.

15. (4) Selaginella and Salvinia
Most pteridophytes produce a single type of spore and are termed homosporous. However, certain genera like Selaginella and Salvinia produce two distinct types of spores: large megaspores and small microspores. This condition, known as heterospory, is a significant evolutionary precursor to the seed habit. Megaspores develop into female gametophytes, while microspores give rise to male gametophytes, ensuring specialized reproductive roles for each.

16. (1) (A) is true but (R) is false.
In gymnosperms, pollen grains are released from microsporangia and transported primarily by air currents to reach the ovules. Upon reaching the micropyle, the pollen grain germinates to form a pollen tube. This tube carries the male gametes toward the archegonia located within the ovules. While wind dispersal is true, the claim that a pollen tube is not formed is incorrect for these plants.

17. (1) All pteridophytes exhibit haplo-diplontic pattern.
Pteridophytes and bryophytes both follow a haplo-diplontic life cycle, where both haploid and diploid phases are multicellular. In pteridophytes, the diploid sporophyte is the dominant and independent phase. In contrast, seed-bearing plants like gymnosperms and angiosperms follow a diplontic pattern. Most algal genera are haplontic, although there are exceptions like Fucus which is diplontic and Ectocarpus which is haplo-diplontic in nature.

18. (2) Ulothrix - Mannitol
Algae store food in various forms depending on their classification. Red algae like Porphyra store floridean starch. Green algae such as Volvox and Ulothrix store standard starch within their cells. Brown algae, including Ectocarpus and Fucus, store complex carbohydrates like mannitol and laminarin. Therefore, matching Ulothrix with mannitol is incorrect because green algae do not produce this specific sugar alcohol as their primary reserve.

19. (3) Rhodophyceae only
Hydrocolloids are water-holding substances produced by certain marine algae. Carrageen is a specific sulfated polysaccharide obtained exclusively from red algae, also known as Rhodophyceae. Another common hydrocolloid,

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algin, is produced by brown algae or Phaeophyceae. These substances are widely used in various industries for their gelling and thickening properties. Red algae are the sole source of carrageen, making other algal classes irrelevant for its production.

20. (2) (A) - (ii), (B) - (iii), (C) - (iv), (D) - (i)
Spirogyra exhibits a haplontic life cycle with a dominant free-living gametophyte. Ferns have a dominant diploid sporophyte alternating with a reduced gametophyte called a prothallus. Funaria shows a dominant leafy gametophyte with a partially dependent sporophyte. Cycas, a gymnosperm, possesses a dominant diploid sporophyte and highly reduced gametophytes. These diverse patterns represent the evolutionary transition from gametophyte-dominant to sporophyte-dominant phases across different plant groups.

21. (4) Red algae
Certain marine algae produce large amounts of hydrocolloids, which are substances that can hold significant quantities of water. Carrageen is a well-known hydrocolloid extracted from red algae, members of the class Rhodophyceae. It is used commercially in the food and pharmaceutical industries. While brown algae produce algin, red algae are the specific sources of carrageen. Green algae and blue-green algae do not produce this particular substance.

22. (2) Ectocarpus
Mannitol is a complex carbohydrate and sugar alcohol that serves as a primary reserve food material in brown algae, belonging to the class Phaeophyceae. Ectocarpus is a typical representative of this group. Green algae like Ulothrix and Volvox store food as starch. Red algae like Gracilaria store it as floridean starch. Identifying the class of the organism is crucial for determining the specific type of stored nutrients.

23. (1) some liverworts
Gemmae are specialized structures used for asexual reproduction in certain bryophytes, specifically within the group known as liverworts. For instance, Marchantia develops these green, multicellular, asexual buds inside small cups called gemma cups. Upon being detached from the parent plant, these gemmae germinate and grow into new individuals. This mechanism is not found in mosses, pteridophytes, or gymnosperms, which use different methods for their asexual or vegetative propagation.

24. (1) heterosporous
In the plant kingdom, species that produce two distinct sizes and types of spores are called heterosporous. Large spores, known as megaspores, develop into female gametophytes, while smaller spores, called microspores, develop into male gametophytes. Selaginella and Salvinia are classic examples of pteridophytes exhibiting this condition. This trait is considered a vital evolutionary step toward the development of the seed habit, found in all higher vascular plants today.

25. (3) Chara
A monoecious plant possesses both male and female reproductive organs on the same individual. Chara, a green alga, is a classic example where the globule and nucule are found on the same plant body. In contrast, Cycas and Marchantia are dioecious, meaning male and female organs are located on separate plants. Papaya is also typically dioecious. Chara is specifically known for its complex and localized reproductive structures on a single thallus.

26. (2) amylopectin and glycogen
Red algae store their reserve food in the form of floridean starch. This polysaccharide is chemically very similar to the branched structures of amylopectin and glycogen found in other organisms. It consists of glucose units linked together in a specific arrangement that allows for efficient energy storage. This similarity is an important biochemical characteristic used to distinguish Rhodophyceae from other algal groups like Chlorophyceae or Phaeophyceae, which store different carbohydrates.

27. (4) Chlorella and Spirulina
Chlorella and Spirulina are both single-celled organisms categorized as algae. They are well-known for being exceptionally rich in proteins and are frequently used as food supplements, even by space travelers. In contrast, Volvox is colonial, and Laminaria, Sargassum, Gelidium, and Gracilaria are multicellular. Spirulina is technically a cyanobacterium but is traditionally grouped with algae in many botanical contexts. Both represent microscopic, unicellular forms that perform photosynthesis independently within a single cell.

NODIA

28. (4) Equisetum.
Strobili or cones are compact structures formed by the clustering of sporophylls that bear sporangia. In pteridophytes, these structures are notably present in genera such as Equisetum and Selaginella. Equisetum, commonly known as horsetail, possesses distinct terminal cones on its fertile branches. Other plants like Marchantia produce different reproductive structures, while Salvinia and Pteris do not form true compact cones. These cones are essential for the production and protection of spores.

29. (1) Uniflagellate gametes - Polysiphonia
Red algae, such as Polysiphonia, are characterized by the complete absence of flagellated stages in their life cycle. Their gametes and spores are non-motile. Brown algae produce biflagellate zoospores with two unequal lateral flagella. Marchantia is a liverwort that possesses gemma cups for asexual reproduction. Chlorella is a well-known unicellular green alga. Therefore, claiming that Polysiphonia has uniflagellate gametes is incorrect since it lacks any flagellated reproductive cells entirely.

30. (1) Ovules are not enclosed by ovary wall in gymnosperms.
Gymnosperms are defined by having naked ovules that are not enclosed within an ovary wall before or after fertilization. Both Selaginella and Salvinia are heterosporous pteridophytes, not homosporous. Horsetails belong to pteridophytes, not gymnosperms. In gymnosperms like Cycas, the stem is unbranched, but in Cedrus and Pinus, the stems are typically branched. Thus, the exposed nature of the ovules remains the unique and defining characteristic for the gymnosperm group.

31. (1) Volvox
Volvox is a classic example of a colonial green alga where many individual cells are arranged in a hollow sphere. These cells are embedded in a gelatinous matrix and coordinate their flagellar movement to swim. Other algae like Ulothrix and Spirogyra are filamentous, consisting of cells joined end-to-end. Chlorella is a unicellular alga that exists as a single, independent cell. The colonial organization of Volvox represents a unique level of biological complexity.

32. (4) Pinus - Dioecious
In gymnosperms, the distribution of male and female reproductive structures varies between genera. Pinus is a monoecious plant, meaning both male and female cones are borne on the same tree. In contrast, Cycas is dioecious, with male and female structures occurring on separate individuals. Salvinia is indeed heterosporous, and Equisetum is typically homosporous. Therefore, labeling Pinus as dioecious is a mismatch because it carries both sexes on a single plant body.

33. (3) Chlamydomonas
Zygotic meiosis is a characteristic feature of organisms with a haplontic life cycle. In these organisms, the only diploid stage is the zygote, which undergoes meiosis immediately after formation to produce haploid spores or cells. Chlamydomonas, a green alga, follows this pattern. In contrast, bryophytes like Funaria and Marchantia exhibit sporic meiosis, where meiosis occurs in the sporophyte to form spores. Fucus is an exception among algae, as it shows a diplontic life cycle.

34. (2) haplodiplontic, diplontic
Algae show a wide variety of life cycle patterns across different genera. Ectocarpus, a brown alga, exhibits a haplo-diplontic life cycle where both haploid and diploid phases are multicellular and morphologically similar. Conversely, Fucus, another brown alga, is unique because it follows a diplontic life cycle where the diploid phase is dominant and the haploid phase is represented only by gametes. Most other algae are typically haplontic, making these two genera notable exceptions.

35. (2) Algin is obtained from red algae, and carrageenan from brown algae.
Marine algae produce various hydrocolloids with industrial importance. Algin is a substance extracted from the cell walls of brown algae, such as Laminaria. Carrageenan is a hydrocolloid obtained from red algae like Chondrus. Therefore, stating that algin comes from red algae and carrageenan from brown algae is incorrect as it reverses their true biological sources. Other facts, like algae increasing dissolved oxygen and agar being obtained from Gelidium, are scientifically accurate.

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36. (2) water
In both bryophytes and pteridophytes, water is absolutely essential for the process of sexual reproduction. These plants produce motile male gametes, called antherozoids, which must swim through a film of water to reach the stationary egg located within the archegonium. Without the presence of external water, fertilization cannot occur, which is why these plants are typically restricted to moist and shady habitats. This dependence distinguishes them from higher plants like gymnosperms and angiosperms.

37. (3) thick cuticle
Conifers are gymnosperms that have evolved several structural adaptations to survive in extreme environmental conditions, such as high temperatures and limited water. Their leaves are needle-like to reduce surface area, and they possess a thick cuticle to minimize water loss through transpiration. Additionally, they have sunken stomata, rather than superficial ones, to further conserve moisture. These features allow them to thrive in harsh climates where other plants might struggle to maintain their water balance.

38. (1) Sequoia is one of the tallest trees.
Sequoia sempervirens, commonly known as the giant redwood, is one of the tallest tree species in the world and belongs to the gymnosperms. Gymnosperms are exclusively heterosporous, meaning they produce two types of spores. Their leaves are well-adapted to survive extreme climatic conditions. While Pinus and Ginkgo are gymnosperms, Salvinia is a pteridophyte. Therefore, the statement regarding Sequoia being among the tallest trees is the only accurate biological fact in the given options.

39. (2) Mannitol is stored food in Rhodophyceae.
Stored food materials vary among the classes of algae. Rhodophyceae, or red algae, store food as floridean starch, which is structurally similar to amylopectin and glycogen. Mannitol and laminarin are the characteristic storage carbohydrates of Phaeophyceae, or brown algae. Therefore, the claim that mannitol is stored in red algae is incorrect. Other statements about Chlorella being space food and agar-agar being derived from Gelidium and Gracilaria are accurate descriptions of algal properties and uses.

40. (1) Ectocarpus
Flagellated or motile male gametes are found in several groups of algae. Ectocarpus, a brown alga, produces biflagellate gametes that enable them to swim in water. In contrast, Spirogyra produces non-flagellated isogametes, and Polysiphonia, a red alga, entirely lacks flagellated stages in its life cycle. Anabaena is a cyanobacterium and does not produce flagellated gametes. The presence of flagella is a key feature for identifying the reproductive strategies and taxonomic classification of various aquatic organisms.

41. (2) Pinus
In bryophytes like Funaria and Marchantia, the gametophyte is the dominant and independent phase of the life cycle. In pteridophytes like Pteris, the gametophyte, although small, is still a free-living, independent structure called a prothallus. However, in gymnosperms like Pinus, the male and female gametophytes are highly reduced and remain entirely dependent on the parent sporophyte for nutrition and protection. They do not have an independent, free-living existence outside the tissues of the sporophyte plant.

42. (1) A, D and E
Mosses and lichens are primary colonizers of bare rocks, initiating ecological succession. In bryophytes, the gametophyte is the main plant body, while in pteridophytes, the sporophyte is dominant. In gymnosperms, gametophytes develop within sporangia on the sporophyte. However, Selaginella is heterosporous, not homosporous, and Cycas roots contain cyanobacteria, not VAM. Therefore, only statements A, D, and E are scientifically correct. This reflects the evolutionary transitions and symbiotic relationships found within these diverse plant groups.

43. (4) Mucor has biflagellate zoospores.
Gymnosperms are characterized by a haploid endosperm that develops before fertilization. Brown algae possess pigments like chlorophyll a, c, and fucoxanthin. Archegonia are the female reproductive organs common to bryophytes, pteridophytes, and gymnosperms. However, Mucor is a fungus that typically lacks motile stages in its life cycle; it produces non-motile sporangiospores rather than biflagellate zoospores. Therefore, the statement about Mucor

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is incorrect. These biological details are essential for distinguishing between various groups of plants and fungi.

44. (3) Upper antheridium and lower oogonium
Chara is a green alga with complex multicellular sex organs. The female organ, called the oogonium or nucule, is situated at the top, while the male organ, known as the antheridium or globule, is located below it on the same plant. Therefore, the statement suggesting an upper antheridium and lower oogonium is incorrect. Both structures develop on the nodes of the plant, facilitating sexual reproduction in this monoecious species through the production of specialized male and female gametes.

45. (4) Spirogyra
Isogamy is a type of sexual reproduction where the fusing gametes are similar in size and appearance. In the green alga Spirogyra, these gametes are non-flagellated and non-motile, moving via a conjugation tube. In contrast, Ulothrix shows isogamy with flagellated gametes. Ectocarpus exhibits isogamy, anisogamy, or oogamy with motile cells. Sargassum is oogamous. Therefore, Spirogyra is the specific example characterized by isogamous fusion of non-motile gametes, which is an important feature in its reproductive biology.

46. (4) Sphagnum
Sphagnum, commonly known as peat moss, is responsible for the formation of peat over long periods. As the moss dies and accumulates in acidic, waterlogged bog environments, it does not fully decay, eventually forming a carbon-rich material called peat. Peat has historically been used as fuel and for its water-retaining properties in horticulture. Other bryophytes like Marchantia, Riccia, and Funaria do not contribute to peat formation in this significant manner, making Sphagnum unique in its ecological role.

47. (1) In oomycetes, female gamete is smaller and motile, while male gamete is larger and non-motile.
In oogamy, which is observed in Fucus and many higher organisms, the female gamete is typically large and non-motile, while the male gamete is small and motile. The statement describing oomycetes with a smaller motile female gamete and a larger non-motile male gamete is exactly the opposite of the true biological condition. Isogametes are structurally similar, while anisogametes differ in size or behavior. Chlamydomonas is versatile, showing various types of gametic fusion depending on the species involved.

48. (4) Spirogyra.
Isogamy refers to the fusion of two gametes that are morphologically identical. In Spirogyra, these gametes are non-flagellated, meaning they cannot move independently. Instead, they come together during conjugation. Conversely, Volvox and Fucus are oogamous, featuring a large non-motile egg and a small motile sperm. Chlamydomonas typically produces flagellated isogametes, although some species show anisogamy or oogamy. Thus, the specific combination of isogamy with non-motile gametes is a defining reproductive characteristic of the alga Spirogyra.

49. (2) upper oogonium and lower antheridium on the same plant
Chara is a monoecious green alga, meaning it bears both male and female reproductive structures on a single individual. The female structure, known as the oogonium or nucule, is positioned above the male structure, called the antheridium or globule. This specific vertical arrangement on the nodes of the plant is a characteristic taxonomic feature. Unlike higher plants, Chara does not possess stamens, carpels, or specialized gametophores like archegoniophores, which are found in groups such as liverworts.

50. (1) Spirogyra - Motile gametes
Spirogyra is a filamentous green alga that reproduces sexually through conjugation. During this process, the gametes involved are non-flagellated and non-motile. Therefore, matching Spirogyra with motile gametes is incorrect. Other matches are accurate: Sargassum is a brown alga containing chlorophyll and other pigments; Basidiomycetes include fungi like puffballs; and certain cyanobacteria like Nostoc can form water blooms in nutrient-rich environments. Identifying the motility of reproductive cells is essential for distinguishing between various groups of algae.

51. (2) algae
Syngamy, or the fusion of gametes, can occur either inside or outside the body of an organism. In many aquatic algae, gametes are released into

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the surrounding water where fertilization takes place externally. This process is common in most algae and some aquatic animals. In contrast, mosses, ferns, and fungi generally exhibit internal fertilization or specialized mechanisms within reproductive organs. The aquatic habitat of most algae facilitates this external fusion, which is a primitive yet effective reproductive strategy.

52. (3) Marchantia
A thalloid plant body is one that is not differentiated into true roots, stems, or leaves. Marchantia is a classic example of a liverwort that possesses a dorsiventrally flattened, thalloid structure. In contrast, mosses like Funaria and Sphagnum have a more complex organization with leaf-like and stem-like structures, although they still lack true vascular tissues. Salvinia is a pteridophyte with a differentiated sporophytic body. Therefore, Marchantia represents the simpler, thalloid level of organization within the bryophytes.

53. (1) Three
Statements A, B, and C are correct. Liverworts, mosses, and ferns have free-living gametophytes. Gymnosperms and some ferns like Salvinia are heterosporous. Fucus, Volvox, and Albugo show oogamous reproduction. Statement D is incorrect because the moss sporophyte is more elaborate than the liverwort sporophyte. Statement E is incorrect as Pinus is monoecious while Marchantia is dioecious. Consequently, exactly three of the five provided statements are biologically accurate, reflecting the diverse reproductive and structural characteristics of these plants.

54. (1) Presence of archegonia
Archegonia are the multicellular female reproductive organs found in bryophytes, pteridophytes, and gymnosperms. Funaria is a bryophyte, Dryopteris is a pteridophyte, and Ginkgo is a gymnosperm, so all three share this common feature. However, vascular tissues are absent in Funaria. While Funaria and Dryopteris have independent gametophytes, the gametophyte in Ginkgo is dependent. Similarly, only Dryopteris and Ginkgo have independent sporophytes.
Thus, the presence of archegonia is the only unifying characteristic among these three diverse plant groups.

55. (4) Multiplication by fragmentation
Fragmentation is a common method of asexual reproduction where an organism breaks into parts, each capable of growing into a new individual. This process is shared by multicellular fungi, filamentous algae like Spirogyra, and the protonema stage of mosses. These groups differ significantly in other aspects: fungi are not part of Kingdom Plantae and have heterotrophic nutrition, while algae and mosses are autotrophic. Additionally, they exhibit various life cycle patterns, making fragmentation their primary shared reproductive feature.

56. (4) Origin of seed habit can be traced in pteridophytes.
The origin of the seed habit is traced back to heterosporous pteridophytes like Selaginella, where the female gametophyte is retained on the parent sporophyte. This retention and the development of the zygote within the female gametophyte are crucial precursors to seed formation. In gymnosperms, the female gametophyte is not free-living. Pteridophytes do not have a protonemal stage; that is characteristic of mosses. Gametophores like archegoniophores are typical of certain liverworts rather than pteridophytes in general.

57. (2) motile sperms
Cycas is a gymnosperm and Adiantum is a pteridophyte. Despite belonging to different groups, they both exhibit the primitive character of producing motile, flagellated male gametes or sperms. These sperms require a fluid medium to swim toward the egg for fertilization. Other features differ: Cycas produces seeds but Adiantum does not. Adiantum lacks cambium and vessels, while Cycas also typically lacks vessels in its xylem. Therefore, the presence of motile sperms is the key shared characteristic between them.

58. (4) One
Among the statements, only the one stating that in Ginkgo the male gametophyte is not independent is correct. In gymnosperms, gametophytes are always dependent. Statement A is wrong because Equisetum is homosporous and its gametophyte is free-living. Statement C is incorrect because Polytrichum has a more developed sporophyte than Riccia. Volvox is oogamous, making D incorrect. Slime mould spores have cellulosic cell

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walls, so E is also wrong. Thus, only a single statement is scientifically accurate.

59. (2) Salvinia - Prothallus
Salvinia is a heterosporous pteridophyte. In heterosporous plants, the gametophytes are highly reduced and develop within the spore wall, rather than forming a free-living, conspicuous prothallus typical of homosporous ferns. Other matches are correct: Ginkgo possesses archegonia; viroids consist of free RNA without a protein coat; and mustard is an angiosperm with synergids in its embryo sac. Therefore, the association of Salvinia with a traditional prothallus is inaccurate due to its heterosporous nature and reduced gametophytic phase.

60. (3) Six
Autotrophs are organisms that can produce their own food. In the provided list, Nostoc and Porphyra are photosynthetic autotrophs. Chara and Wolffia are also photosynthetic plants. Nitrosomonas and Nitrobacter are chemoautotrophs that obtain energy from inorganic nitrogen compounds. On the other hand, Lactobacillus, Streptomyces, Saccharomyces, and Trypanosoma are heterotrophs that rely on external organic sources. Thus, there are exactly six autotrophic organisms in the list, representing both photoautotrophic and chemoautotrophic modes of nutrition.

61. (1) Archegoniophore Female thallus Gemma cup Rhizoids
The figure depicts a female thallus of the liverwort Marchantia. The part labeled A is the archegoniophore, which is the specialized stalk bearing the female reproductive organs. B represents the main body or female thallus itself. C indicates the gemma cups, which are small receptacles used for asexual reproduction. D shows the rhizoids, which are hair-like structures used for anchorage and absorption. Correct identification of these parts is fundamental for understanding the morphology and life cycle of bryophytes.

62. (4) smaller and to have smaller sex organs.
Evolutionarily, there is a trend toward the reduction of the gametophytic phase in vascular plants compared to bryophytes. In bryophytes, the gametophyte is the dominant, larger, and independent stage. In vascular plants like pteridophytes, gymnosperms, and angiosperms, the gametophyte becomes progressively smaller and more inconspicuous. Along with this reduction in size, the sex organs also become smaller and less complex. In higher vascular plants, the gametophyte is microscopic and entirely dependent on the dominant sporophyte generation.

63. (1) Marchantia
An archegoniophore is a specialized, stalk-like structure that bears the archegonia, the female reproductive organs, in certain bryophytes. This structure is a characteristic feature of the liverwort genus Marchantia. Other plants like Chara produce reproductive organs directly on their thallus. Adiantum is a pteridophyte that produces archegonia on a small, independent prothallus. Funaria is a moss where archegonia are borne at the apex of the leafy gametophyte but lack a specialized stalked archegoniophore like that of Marchantia.

64. (4) embryo develops in female gametophyte which is retained on parent sporophyte.
Selaginella and Salvinia are heterosporous pteridophytes that represent a critical step toward the seed habit. In these plants, the female gametophyte is not released but is retained on the parent sporophyte for a variable period. The fertilization and subsequent development of the embryo occur within this retained female gametophyte. This protection and nourishment of the developing embryo by the parent sporophyte is a fundamental requirement for the evolution of seeds, as seen in gymnosperms and angiosperms today.

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65. (2) A and D
Statement A is wrong because the sporophyte in mosses is actually more elaborate and complex than that in liverworts. Statement D is wrong because Pinus is a monoecious plant, where both male and female cones are found on the same tree. On the other hand, Salvinia is correctly identified as heterosporous, and all seed-bearing plants indeed follow a diplontic life cycle. Therefore, statements A and D represent the two incorrect biological assertions among the four options provided.

66. (1) cellulose, galactans and mannans
The cell walls of algae are primarily composed of cellulose, but they also contain other specific polysaccharides that vary between groups.

Common components include galactans and mannans, along with minerals like calcium carbonate in some species. This composition distinguishes them from higher land plants, whose cell walls typically contain hemicellulose, pectins, and proteins in addition to cellulose. Understanding these chemical differences is crucial for the taxonomic classification of algae and for distinguishing them from other plant groups.

67. (3) Selaginella Equisetum Salvinia Ginkgo
The figures represent different groups of vascular plants. A is Selaginella, a heterosporous pteridophyte with small leaves. B is Equisetum, known as horsetail, which has a distinct jointed stem and terminal strobilus. C is Salvinia, an aquatic pteridophyte that is also heterosporous. D is Ginkgo biloba, a gymnosperm characterized by its unique fan-shaped leaves. Correct identification of these genera is based on their distinct morphological features and reproductive structures, which are key to understanding plant diversity and evolution.

68. (4) Sphagnum.
In bryophytes like Sphagnum, the gametophyte is the dominant, independent, and free-living stage of the life cycle. Both male and female gametes are produced on these independent structures. In contrast, for seed plants like mustard, castor, and Pinus, the gametophytes are highly reduced and entirely dependent on the sporophyte. They are never free-living. This fundamental difference in the dominance of generations is a key evolutionary distinction between bryophytes and the more advanced vascular, seed-bearing plants.

69. (4) evolutionary relationships.
Phylogenetic systems of classification are designed to reflect the evolutionary history and relationships among different organisms. Unlike artificial systems that use one or a few morphological characters, or natural systems that consider many observable traits, phylogenetic systems use data from fossils, genetics, and molecular biology to group organisms based on their common ancestry. This approach helps scientists understand how different species evolved over time and how they are related to one another through a shared evolutionary descent.

70. (2) Fucus
Mannitol is a complex carbohydrate and sugar alcohol that serves as the characteristic storage food in members of the class Phaeophyceae, or brown algae. Fucus is a prominent example of this group. Red algae, such as Porphyra and Gracilaria, store their food as floridean starch. Green algae like Chara store food in the form of starch. Identifying the storage product is a key biochemical method used by taxonomists to classify algae into their respective major groups.

71. (1) Heterospory
Heterospory, the production of two different types of spores, is considered the most important step in the development of the seed habit. It involves the formation of large megaspores and small microspores. The retention of the megaspore and the subsequent development of the female gametophyte within the parent sporophyte are essential for seed evolution. While other factors like a dependent sporophyte are important in different contexts, heterospory provided the necessary reproductive specialization that eventually led to seeds.

72. (4) Equisetum
Vascular cryptogams are plants that possess vascular tissues like xylem and phloem but do not produce seeds. This group corresponds to the pteridophytes. Equisetum, commonly known as horsetail, is a typical vascular cryptogam. In contrast, Marchantia is a bryophyte and lacks vascular tissues. Ginkgo and Cedrus are gymnosperms, which are vascular plants that do produce seeds. Therefore, Equisetum is the correct example of a plant that has vascular tissues but reproduces via spores rather than seeds.

73. (2) Ustilago
A haplontic life cycle is one where the multicellular stage is haploid and the only diploid stage is the zygote. This pattern is common in many fungi and some algae. Ustilago, a fungus, exhibits a primarily haplontic life cycle. Bryophytes like Polytrichum and Funaria follow a haplo-diplontic life cycle with a dominant gametophyte. Wheat, an angiosperm, has a diplontic life cycle where the sporophyte is the dominant phase. Thus, Ustilago is the representative for the haplontic pattern.

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74. (4) Salvinia
Heterospory is the condition of producing two different types of spores: megaspores and microspores. While most pteridophytes are homosporous, certain genera like Salvinia and Selaginella are heterosporous. These two types of spores develop into female and male gametophytes, respectively. In contrast, other pteridophytes like Adiantum, Equisetum, and Dryopteris produce only one type of spore and are therefore homosporous. Heterospory is a significant evolutionary trait because it is a direct precursor to the development of the seed habit.

75. (2) Cedrus
In gymnosperms like Cedrus, the male and female gametophytes are highly reduced and do not have an independent, free-living existence. They remain enclosed within the sporangia on the parent sporophyte for their entire development. In contrast, bryophytes like Polytrichum and Funaria have a dominant, free-living gametophyte stage. Pteridophytes like Pteris also have a small but independent gametophyte called a prothallus. Therefore, the lack of an independent gametophyte phase is a defining characteristic of advanced seed-bearing plants.

76. (4) Presence of vessel elements and absence of archegonia
Gnetum is a unique gymnosperm that shows several advanced features similar to angiosperms, distinguishing it from more primitive gymnosperms like Cycas and Pinus. Key differences include the presence of vessel elements in its xylem, whereas most gymnosperms only have tracheids. Additionally, Gnetum lacks archegonia in its female gametophyte, which is another trait common in angiosperms but rare in gymnosperms. These features make Gnetum an important evolutionary link between the two major groups of seed-bearing plants.

77. (4) Types of pigments present in the cell
The primary character used to classify algae into their major groups, such as Chlorophyceae, Phaeophyceae, and Rhodophyceae, is the specific combination of photosynthetic pigments they contain. For instance, green algae are characterized by chlorophyll a and b, brown algae by fucoxanthin, and red algae by phycoerythrin. While other characters like stored food and cell wall composition are also important, the pigment types remain the most fundamental and universally used criteria for their initial taxonomic grouping and identification.

78. (4) elaters.
In many liverworts, such as Marchantia, spore dispersal is aided by specialized hygroscopic structures called elaters. These are elongated cells with spiral thickenings that change shape in response to moisture levels. As they dry out, they twist and coil, effectively flicking the spores out of the capsule for dispersal. Peristome teeth perform a similar role in mosses, while indusium is a protective covering in ferns and calyptra is a protective cap in bryophytes. Thus, elaters are unique to liverworts.

79. (3) self fertilization is prevented
In the prothallus of many vascular cryptogams or pteridophytes, the male organs (antheridia) and female organs (archegonia) mature at different times. This condition, known as dichogamy, is a biological strategy to prevent self-fertilization and encourage cross-fertilization. By ensuring that eggs and sperms are not ready simultaneously on the same gametophyte, the plant increases genetic diversity within its population. This does not lead to sterility or apomixis but rather serves as a mechanism for improving the overall health of the species.

80. (1) a cavity in the ovule in which pollen grains are stored after pollination
In gymnosperms, the pollen chamber is a specialized cavity located at the apex of the nucellus within the ovule. After pollination, pollen grains are collected in this chamber, where they eventually germinate to form pollen tubes. This structure provides a protected environment for the initial stages of male gametophyte development. It is distinct from the microsporangium, where pollen is produced, and from the micropyle, which is the actual opening through which the pollen grains enter the ovule.

81. (3) Riccia, Dryopteris and Cycas
Flagellated male gametes are found in bryophytes, pteridophytes, and some primitive gymnosperms. In the set containing Riccia (a bryophyte), Dryopteris (a pteridophyte), and Cycas (a gymnosperm), all three produce motile, flagellated sperms that require water or a fluid medium to reach the egg. Other sets include

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plants like Hydrilla, Calotropis, or Spirogyra, which do not produce flagellated gametes or use different reproductive strategies. Therefore, this specific group correctly represents the evolutionary persistence of motile sperms across these three plant divisions.

82. (3) it is hygroscopic
Sphagnum, commonly known as peat moss, is widely used as a packing material for shipping live plants and flowers over long distances. This is because the moss is highly hygroscopic, meaning it has an exceptional ability to absorb and retain large quantities of water. This property keeps the transported plants moist and prevents them from drying out during transit. While it may have some minor antibacterial properties, its primary value in commercial shipping is its superior water-holding capacity.

83. (2) is partially parasitic on the gametophyte
In mosses, the sporophyte is not a completely independent generation. It remains physically attached to the dominant gametophyte, from which it derives anchorage and most of its water and mineral requirements. Although many moss sporophytes are green and can perform some photosynthesis, they are still considered partially parasitic because they depend on the gametophyte for survival and nutrition throughout their life cycle. This relationship is a fundamental characteristic of the bryophyte life cycle, where the sporophyte is temporary.

84. (1) formation of endosperm before fertilization
One of the key differences between gymnosperms like conifers and angiosperms like grasses is the timing and nature of endosperm formation. In gymnosperms, the endosperm is a haploid tissue that develops from the female gametophyte before fertilization occurs. In contrast, in angiosperms, the endosperm is typically a triploid tissue formed as a result of double fertilization. Both groups produce seeds and use pollen tubes, but the origin and ploidy of the nutritive tissue or endosperm remain a major distinguishing feature.

85. (1) Osmunda and Equisetum
An ectophloic siphonostele is a type of vascular arrangement where a ring of xylem surrounds a central pith, and phloem is present only on the outside of the xylem. This specific stelar structure is found in certain pteridophytes, most notably in the stems of Osmunda and Equisetum. Other plants like Marsilea exhibit amphiphloic siphonosteles, where phloem is present on both the inner and outer sides of the xylem. Understanding these anatomical variations is important for studying the evolutionary development of vascular systems.

86. (1) A - L; B - J; C - M; D - N; E - K
Peritrichous flagellation is a characteristic of bacteria like Escherichia coli. Ginkgo is a well-known living fossil among gymnosperms. Selaginella is notable for producing rhizophores, which are root-like structures. Wolffia is recognized as the smallest flowering plant or angiosperm. Macrocystis is one of the largest perennial brown algae, often forming underwater kelp forests. These diverse biological examples highlight the range of structural and functional adaptations found across different kingdoms of life, from bacteria to complex multicellular plants.

87. (1) cycads
Cycads are a group of primitive gymnosperms characterized by several unique reproductive features. They produce exceptionally large, top-shaped male gametes that are covered with thousands of cilia, making them motile. Additionally, their mature seeds typically contain a single embryo with two cotyledons. While other gymnosperms like conifers have non-motile sperms, cycads retain this ancestral trait. These features, along with their palm-like appearance, distinguish cycads from other seed plants, including both more advanced gymnosperms and all various groups of angiosperms.

88. (1) observable characteristics of existing organisms
Phenetic classification, also known as numerical taxonomy, is based on the overall similarity of organisms using a wide range of observable morphological and other characteristics. This system does not primarily consider the ancestral lineage or evolutionary history of the organisms. Instead, it uses statistical methods to group organisms based on shared traits. Each character is given equal weight, and the degree of similarity is calculated to determine taxonomic relationships. This approach is distinct from phylogenetic classification, which focuses on common descent.

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89. (1) Cycas
A living fossil is an organism that has remained essentially unchanged over millions of years and has few living relatives. Cycas is a classic example of a living fossil among the gymnosperms, as it retains many primitive features from the age of cycads. Other organisms like mosses, Saccharomyces (a yeast), and Spirogyra (an alga) are not typically classified as living fossils in this context. Cycas provides valuable insights into the evolutionary history of seed plants due to its ancient and stable morphology.

90. (1) power of adaptability in diverse habitat
Angiosperms, or flowering plants, have become the dominant land flora primarily due to their extraordinary power of adaptability in a wide variety of habitats. They have evolved diverse forms, including trees, shrubs, and herbs, and possess efficient vascular systems and specialized reproductive structures like flowers and fruits. These adaptations allow them to thrive in environments ranging from deserts to tropical rainforests. While seed production and pollination are important, their overall ecological flexibility is the main factor behind their global success.

91. (4) physiologically differentiated sex organs.
Sexual reproduction in the green alga Spirogyra occurs through a process called conjugation. Although the gametes are morphologically identical (isogamous) and both are non-motile, they are considered to be physiologically differentiated. During conjugation, one gamete acts as the active "male" by moving through the conjugation tube, while the other remains passive as the "female." This physiological distinction between the gametes, despite their similar appearance, is regarded as an advanced evolutionary feature compared to simpler forms of isogamy where no such differentiation exists.

92. (1) cryptogams
Plants that reproduce by spores rather than seeds are traditionally grouped under the general term cryptogams. This group includes algae (thallophytes), bryophytes (like mosses), and pteridophytes (like ferns). The name "cryptogam" means "hidden reproduction," referring to the fact that these plants do not produce visible flowers or seeds. In contrast, plants that produce seeds are called phanerogams. While bryophytes and thallophytes are subgroups within the cryptogams, the term itself is the broadest category for all non-seed-bearing plants that reproduce via spores.

93. (1) Fern and Funaria
Ferns are pteridophytes and Funaria is a moss belonging to the bryophytes. Neither of these groups produces seeds; instead, they reproduce through the formation of spores. In contrast, Ficus is an angiosperm and Pinus is a gymnosperm, both of which are seed-producing plants. Chlamydomonas is an alga that also reproduces via spores and does not produce seeds. Therefore, the pair consisting of Fern and Funaria correctly represents plants that lack the ability to produce seeds, unlike the more advanced vascular seed plants.

94. (2) Cycas
Cycas is categorized as a living fossil because it belongs to an ancient group of plants that was once much more diverse and widespread during the Mesozoic era. It has maintained its primitive morphological features, such as motile sperms and a specific leaf arrangement, for millions of years. While Pinus and Selaginella are also ancient lineages, Cycas is more frequently cited as a classic example of a living fossil. Metasequoia is another well-known living fossil, but Cycas remains a primary example in botanical studies.

95. (4) Ginkgo, Pisum
Spermatophyta is a major group of plants that includes all species that produce seeds. This group is further divided into gymnosperms and angiosperms. Ginkgo is a gymnosperm, and Pisum (pea) is an angiosperm, so both are seed-producing plants and correctly represent the Spermatophyta. Other examples like Rhizopus (a fungus) do not belong to this group. While Acacia, sugarcane, Pinus, and Cycas are also seed plants, the combination of Ginkgo and Pisum effectively illustrates the diversity within the seed-bearing plants across both main divisions.

96. (2) Double fertilisation
Double fertilization is a unique and defining characteristic of angiosperms that occurs without exception in all members of the group. It involves two separate fusion events: one sperm fuses with the egg to form a zygote, and another fuses with the polar nuclei to form the endosperm. Other features like the presence of vessels and secondary growth have exceptions;

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for example, some primitive angiosperms lack vessels, and many monocots do not undergo secondary growth. Autotrophic nutrition also has exceptions in parasitic or saprophytic plants.

97. (4) Pinus
Pinus is a gymnosperm, a group of plants characterized by the production of seeds that are not enclosed within an ovary or a flower. Instead, their seeds develop on the scales of cones. This is why gymnosperms are often called "naked seed" plants. In contrast, Maize, Mint, and Peepal are all angiosperms, which produce seeds within specialized reproductive structures called flowers, and eventually within fruits. Therefore, Pinus is the correct example of a plant that produces seeds but lacks the complex structure of a true flower.

98. (1) naked ovules
Although Cycas has two cotyledons in its embryo, it is classified as a gymnosperm rather than an angiosperm because its ovules are naked and not enclosed within an ovary wall. In angiosperms, the ovules are always protected inside an ovary, which later develops into a fruit. Cycas also exhibits other primitive traits like circinate ptyxis and compound leaves, but the presence of exposed or naked ovules is the fundamental taxonomic reason for its exclusion from the flowering plant group or angiosperms.

99. (2) Rhodophyta
Algae are classified into different divisions based on their characteristic photosynthetic pigments. Rhodophyta, or red algae, are distinguished by the presence of chlorophyll a and d, as well as the red accessory pigment r-phycoerythrin. This pigment allows them to absorb blue light, which penetrates deeper into the ocean, enabling them to live at greater depths. Phaeophyta (brown algae) contain chlorophyll a and c along with fucoxanthin, while Chlorophyta (green algae) have chlorophyll a and b. Bacillariophyta (diatoms) have their own distinct pigment profile.

100. (1) spore formation
In ferns, the dominant plant body is the diploid sporophyte. Meiosis, or reduction division, occurs within the sporangia on the sporophyte at the time of spore formation. This process produces haploid spores, which then germinate to form the haploid gametophyte or prothallus. In contrast, the formation of gametes in the antheridia and archegonia of the gametophyte occurs via mitosis, not meiosis. Therefore, meiosis is specifically associated with the transition from the diploid sporophyte generation to the haploid spore stage.

101. (1) gymnosperm
The gymnosperms are a plant group that holds several records for size in the plant kingdom. They include the largest ovules (found in Cycas), the largest trees (such as the giant redwood Sequoia), and the largest male gametes (also found in Cycas). While angiosperms are more diverse and include many large trees, they do not typically match these specific extremes for ovule and gamete size found in primitive gymnosperms. Bryophytes and pteridophytes are generally much smaller in overall size and in their reproductive structures.

102. (1) natural system
A natural system of classification is one that considers a large number of traits and overall similarities between organisms to determine their relationships. This approach uses multiple morphological, anatomical, and embryological characters rather than just one or two. It aims to group organisms that are truly similar in their entire biological organization. In contrast, artificial systems rely on a few superficial characters, while phylogenetic systems focus specifically on evolutionary history and common ancestry. The natural system provides a more comprehensive view of biological diversity.

103. (4) biciliated.
Funaria is a moss that produces specialized male gametes called antherozoids. These antherozoids are characterized by being small, spirally coiled, and biciliated, meaning they possess two flagella or cilia. These flagella enable the antherozoids to swim through a film of water to reach the archegonium for fertilization. The biciliated condition is common among most bryophytes. In contrast, some other plants, like certain pteridophytes or primitive gymnosperms, may produce multiciliated antherozoids, but Funaria specifically follows the biciliated pattern for its motile male gametes.

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104. (2) small sporophyte phase and generally parasitic on gametophyte
Bryophytes are characterized by a life cycle where the gametophyte is the dominant, independent, and photosynthetic phase. The sporophyte generation is relatively small and short-lived. Importantly, the sporophyte remains physically attached to and is generally dependent on the gametophyte for its nutrition and water supply, a condition often described as being parasitic. This relationship is a key distinguishing feature of bryophytes compared to vascular plants, where the sporophyte is the dominant and independent phase while the gametophyte is reduced.

105. (4) All of these
Bryophytes are a diverse group of non-vascular plants with several common characteristics. Many bryophytes, particularly liverworts, have a simple, thalloid plant body that is not differentiated into true roots, stems, or leaves. They all possess archegonia, which are the multicellular female reproductive organs. Additionally, their cells contain chloroplasts, enabling them to perform photosynthesis and live as autotrophs. Because all these features—thalloid body, archegonia, and chloroplasts—are found within the group, all the provided statements accurately describe the biological nature of bryophytes.

106. (1) liverworts
Dichotomous branching is a type of growth pattern where the main axis or a branch divides into two equal branches at the tip. This primitive form of branching is a characteristic feature of many liverworts, such as Marchantia and Riccia. In these plants, the thallus repeatedly forks into two as it grows across the substrate. While some primitive pteridophytes also show this pattern, it is not a defining feature for ferns or mosses like Funaria, which typically exhibit different types of apical growth and branching.

107. (1) Pteridophytes
Plants that possess well-developed vascular tissues like xylem and phloem for transport but do not produce seeds are classified as pteridophytes. This group includes ferns, horsetails, and club mosses. They represent an evolutionary transition between the non-vascular bryophytes, which also lack seeds, and the vascular gymnosperms and angiosperms, both of which produce seeds. Therefore, the combination of having vascular tissue while being seedless is the defining characteristic of the pteridophyte division within the plant kingdom. They reproduce instead through the production of spores.

108. (4) haploid.
In gymnosperms, the endosperm is a nutritive tissue that develops from the female gametophyte before fertilization takes place. Since the female gametophyte is formed from a haploid megaspore through mitotic divisions, the resulting endosperm tissue is also haploid in nature. This is a major difference from angiosperms, where the endosperm is typically triploid because it is formed by the fusion of a male gamete with two polar nuclei during double fertilization. Thus, the haploid status of the endosperm is a characteristic feature of gymnosperm biology.

109. (3) filamentous alga with flagellated reproductive stages
Ulothrix is a genus of green algae that consists of unbranched, multicellular filaments. It is characterized by having flagellated reproductive stages in its life cycle, including both motile zoospores for asexual reproduction and flagellated gametes for sexual reproduction. The gametes are typically isogamous and biflagellate. This distinguishes it from other algae that might be colonial or lack flagellated stages entirely. The presence of these motile cells is essential for dispersal and fertilization in the aquatic environments where Ulothrix is commonly found.

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110. (2) the sperms can easily reach upto egg in the archegonium
Bryophytes are often called the “amphibians of the plant kingdom” because they require water to complete their sexual reproduction. These plants produce motile male gametes, or sperms, which must swim through a thin film of water to reach the stationary egg located within the archegonium. Without water, the sperms cannot move, and fertilization cannot occur. This dependence on external water for the transport of gametes is the primary reason why bryophytes are typically restricted to moist, damp, and shady environments where such water is readily available.

111. (1) it propagates vegetatively by its leaf tips
The walking fern, scientifically known as Asplenium rhizophyllum, earns its name due to its unique method of vegetative propagation.

When the long, tapering tips of its leaves touch a moist substrate, they develop adventitious roots and new plantlets. As this process repeats, the plant appears to "walk" across the ground over time. This is a form of asexual reproduction that allows the fern to spread efficiently in its habitat. It is not related to animal dispersal or any actual movement of the spores or the whole plant.

112. (2) Its xylem is mainly composed of xylem vessel.
Cycas is a gymnosperm, and like most members of this group, its xylem is primarily composed of tracheids rather than vessels. The absence of vessels is a key anatomical feature that distinguishes gymnosperms from most angiosperms. Other statements about Cycas are correct: it exhibits circinate vernation (coiling of young leaves), its coralloid roots harbor symbiotic blue-green algae for nitrogen fixation, and it does not produce a true, well-organized female flower, instead bearing megasporophylls. Therefore, the claim that its xylem contains vessels is scientifically incorrect.

113. (4) both (1) and (3).
Transfusion tissue is a specialized group of cells found in the leaves of many gymnosperms, including both Pinus and Cycas. This tissue is located around the vascular bundles and is thought to facilitate the lateral transport of water and nutrients between the vascular tissue and the mesophyll cells. Since gymnosperm leaves often have a single central vein or limited venation, transfusion tissue plays a crucial role in ensuring that all parts of the leaf receive adequate hydration. Therefore, it is a characteristic anatomical feature shared by both of these genera.

114. (2) Cycas
In the entire plant kingdom, the largest male gametes or sperms are found in the genus Cycas. These sperms are microscopic but are enormous compared to those of other plants, being visible even to the naked eye in some species. They are top-shaped and covered with thousands of cilia, which provide them with motility to swim toward the egg. While other gymnosperms like Pinus produce non-motile sperms, Cycas retains this primitive and remarkable feature. Banyan and Thuja produce much smaller gametes, making Cycas the record-holder for sperm size.

115. (1) Chlorella
Chlorella is a unicellular green alga that is exceptionally rich in proteins, vitamins, and minerals. Due to its high nutritional value, it is widely used as a food supplement and has been researched as a potential food source for long-duration space missions. While other algae like Spirulina are also protein-rich, Chlorella is a primary example of a highly nutritious photosynthetic organism. Other algae like Nostoc, Spirogyra, and Ulothrix do not typically contain the same high concentration of protein and are not commonly used as human food supplements.

116. (3) isogametes
Ulothrix is a filamentous green alga that primarily reproduces sexually through isogamy. In this process, the plant produces gametes that are morphologically identical in size and shape. These isogametes are biflagellate and motile, allowing them to swim in water and fuse with one another. Unlike some other algae that might show anisogamy (unequal gametes) or oogamy (large egg and small sperm), Ulothrix is a classic example used to illustrate isogamous sexual reproduction. It does not produce basidiospores, which are characteristic of certain groups of fungi.

117. (1) fucoxanthin
Brown algae, belonging to the class Phaeophyceae, are characterized by a specific combination of photosynthetic pigments. While they contain chlorophyll a and c, their most distinctive pigment is the xanthophyll called fucoxanthin. This pigment is responsible for the characteristic olive green to brown color of these algae, as it masks the green color of the chlorophylls. Other pigments like phycocyanin and phycoerythrin are characteristic of blue-green and red algae, respectively. Haematochrome is found in some other specialized algae but is not a defining feature of brown algae.

118. (1) possess archegonia
One of the primary features that separates bryophytes from algae is the presence of specialized, multicellular sex organs. Bryophytes possess archegonia, which are the flask-shaped female reproductive organs that protect the developing egg and zygote. Algae, in contrast, typically have unicellular sex organs, and even when multicellular, they lack a protective jacket

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of sterile cells. While both groups contain chloroplasts and can be thalloid, and both generally lack true vascular or conducting tissue, the evolutionary development of the archegonium is a major distinguishing characteristic of the bryophytes.

119. (2) ligule
Heterospory, the production of two types of spores, and the development of a seed-like habit are significant evolutionary traits often found in certain pteridophytes. A notable structural feature associated with these traits in the genus Selaginella is the presence of a ligule. The ligule is a small, scale-like outgrowth located on the upper surface of the leaf base. While its exact function is not fully understood, it is a consistent morphological characteristic of these heterosporous plants. Petioles, bracts, and spathes are more common in higher vascular plants like angiosperms.

120. (1) some bryophytes
The combination of multicellular, branched rhizoids and leafy gametophytes is a characteristic feature of mosses, which are a subgroup within the bryophytes. For example, Funaria exhibits these traits. In contrast, other bryophytes like liverworts often have unicellular rhizoids and thalloid bodies. Pteridophytes have a dominant sporophyte generation and their gametophytes are typically small and inconspicuous. Gymnosperms do not have independent leafy gametophytes at all. Therefore, these specific anatomical features are key identifiers for the mosses among the various groups of non-vascular and vascular plants.

121. (2) Marchantia
The elater mechanism for spore dispersal is a specialized adaptation found in certain liverworts, most famously in the genus Marchantia. Elaters are sterile, hygroscopic cells with spiral thickenings that are found among the spores inside the capsule. As the capsule dries and opens, the elaters undergo twisting movements due to changes in humidity, which helps to loosen and flick the spores out into the air for wider dispersal. While other plants have different dispersal mechanisms, such as peristome teeth in Funaria, the elater system is a hallmark of Marchantia's reproductive biology.

122. (4) Bryophyta
Bryophytes are commonly referred to as the "amphibians of the plant kingdom." This name is given because, like biological amphibians, they live on land but are absolutely dependent on water for their sexual reproduction. Their motile male gametes must swim through a film of water to reach and fertilize the egg. Without this aquatic medium, their life cycle cannot be completed. This group includes mosses and liverworts, which are typically found in moist and shady habitats to ensure they have the necessary water for both survival and successful reproduction.

123. (4) 900
Gymnosperms are a relatively small group of seed-producing plants compared to the vast number of angiosperm species. While they once dominated the Earth's flora during the Mesozoic era, there are currently only about 900 to 1,000 living species of gymnosperms. These include well-known groups such as conifers, cycads, and ginkgos. Despite their limited number of species, gymnosperms remain ecologically significant, particularly in many of the world's forest ecosystems. The estimated count of approximately 900 species reflects their status as a smaller but still vital division of the plant kingdom.

124. (2) 8
In gymnosperms, the endosperm is a haploid tissue that develops directly from the female gametophyte before fertilization occurs. Therefore, the number of chromosomes in the endosperm cells is exactly half of the number found in the diploid sporophytic tissues, such as the leaves. If a gymnospermic leaf carries 16 chromosomes ($2n = 16$), then its endosperm cells, being haploid (n), will contain only 8 chromosomes. This is a significant difference from angiosperms, where the endosperm is typically triploid and formed through a much more complex process.

125. (1) proteinaceous centre and starchy sheath
Pyrenoids are specialized sub-cellular organelles found within the chloroplasts of many algae and some hornworts. They are primarily involved in the carbon-concentrating mechanism and the synthesis of starch. Structurally, a pyrenoid consists of a dense proteinaceous center, which is often composed mainly of the

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enzyme Rubisco, surrounded by a sheath of starch grains. This unique organization allows for efficient photosynthesis and energy storage. They are not composed of nucleic acids or fatty materials, making the protein core and starch sheath their defining biochemical and structural characteristics.

126. (2) predominantly gametophyte with sporophyte
The life cycle of a moss, such as Funaria, is characterized by the alternation of two distinct generations. The main, conspicuous plant body is the gametophyte, which is haploid, green, and independent. This is the predominant stage that most people recognize as the moss plant. The sporophyte, which is diploid, develops from the zygote and remains physically attached to and partially dependent on the gametophyte for its nutrition. Therefore, the moss plant body is best described as being predominantly gametophytic, with the sporophyte being a temporary and attached generation.

127. (4) bryophytes and pteridophytes.
An archegonium is a multicellular female reproductive organ that is characteristic of bryophytes and pteridophytes. In these groups, the archegonium typically has a well-developed structure consisting of a neck, which contains 4 to 6 rows of cells and several neck canal cells, and a basal swollen part called the venter that houses the egg. While gymnosperms also have archegonia, they are often much simpler and more reduced in structure. Flowering plants or angiosperms lack archegonia entirely. Thus, the classic, complex archegonium structure is most representative of bryophytes and pteridophytes.

128. (4) common evolutionary descent.
Phylogenetic classification is a biological system that groups organisms based on their shared evolutionary history and common descent. The goal of this system is to reflect the true evolutionary relationships among species, showing how they have diverged from common ancestors over time. This approach uses data from various sources, including fossil records, comparative anatomy, and molecular genetics. Unlike systems based solely on superficial habits or utilitarian purposes, phylogenetic classification provides a more accurate and scientifically grounded understanding of the complexity and relatedness of all living things on Earth.

129. (4) all of these.
The class Chlorophyceae, or green algae, exhibits a remarkable diversity in its modes of sexual reproduction. Depending on the species, they may perform isogamy, where the fusing gametes are identical in size and appearance. Some species show anisogamy, involving the fusion of two gametes that differ in size or behavior. Still others exhibit oogamy, where a small motile male gamete fuses with a large, non-motile female gamete or egg. Because all three of these reproductive strategies—isogamy, anisogamy, and oogamy—are found within this class, "all of these" is the correct description.

130. (4) sporophytes are dependent upon gametophytes.
In the life cycle of all bryophytes, there is a clear relationship of dependency between the two generations. The gametophyte is the dominant, independent, and photosynthetic phase that produces the gametes. The sporophyte develops from the zygote within the archegonium and remains permanently attached to the gametophyte throughout its existence. It relies on the gametophyte for physical support, water, minerals, and often a portion of its organic nutrients. This makes the sporophyte dependent on the gametophyte, a fundamental and defining feature that distinguishes bryophytes from the vascular plant groups.

131. (1) ovuliferous scale
In the genus Pinus, the seeds are often equipped with thin, papery wings that aid in their dispersal by the wind. These wings are not derived from the seed coat or the integument itself. Instead, they develop from a portion of the ovuliferous scale on which the seeds are borne. As the seed matures, a layer of the scale's tissue becomes thin and stays attached to the seed when it is eventually released from the cone. This anatomical origin is a specific adaptation of conifers to ensure effective seed distribution.

132. (4) starch.
Pyrenoids are specialized protein-rich organelles found within the chloroplasts of many algae and some other photosynthetic organisms. Their primary biological function is to serve as centers for the formation and storage of starch. During photosynthesis, the carbon dioxide is concentrated around these structures, facilitating the enzyme activity necessary for starch synthesis. As a

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result, pyrenoids are typically surrounded by a sheath of starch grains. They are not involved in the production of enzymes, fats, or specific algal genera like Porphyra, making starch formation their most important and characteristic role.

133. (2) cup-shaped
Chlamydomonas is a unicellular green alga that is easily identified by its characteristic chloroplast. Most species of Chlamydomonas possess a single, large, cup-shaped chloroplast that occupies a significant portion of the cell's interior. This chloroplast contains one or more pyrenoids and is the site of photosynthesis. While other algae may have different chloroplast shapes—such as spiral in Spirogyra, collar-shaped in Ulothrix, or stellate in Zygnema—the cup-shaped chloroplast remains a defining and classic morphological feature of the genus Chlamydomonas in botanical and biological studies.

134. (3) zygospore germination
Both Ulothrix and Spirogyra follow a haplontic life cycle where the main plant body is haploid. In these organisms, the only diploid stage is the zygospore, which is formed after the fusion of gametes. Meiosis, or reduction division, occurs at the time of zygospore germination. This process produces four haploid nuclei, which then grow into new haploid filaments. Meiosis does not occur during gamete or zoospore formation, as those cells are already haploid and produced by mitosis. Therefore, zygospore germination is the specific event where the diploid state is reduced.

135. (2) Funaria
A protonema is a creeping, green, and often filamentous structure that represents the first stage in the development of the gametophyte of a moss. It develops directly from a germinating spore. This stage is a characteristic feature of the life cycle of mosses like Funaria. During its growth, the protonema produces buds that eventually develop into the adult leafy gametophytes. Other bryophytes like Riccia and Anthoceros do not have a prominent protonemal stage, and the alga Spirogyra also lacks this specific developmental phase in its haplontic life cycle.

136. (1) vascular tissues
Pteridophytes represent a significant evolutionary step because they are the first group of terrestrial plants to possess well-developed vascular tissues, namely xylem and phloem. These tissues allow for the efficient transport of water, minerals, and nutrients throughout the plant body, enabling pteridophytes to grow much larger than their non-vascular predecessors. While bryophytes and thallophytes (algae) share features like motile antherozoids and alternation of generations, and bryophytes also have archegonia, the presence of a specialized vascular system is the key feature that distinguishes pteridophytes from these two simpler plant groups.

137. (2) well developed vascular system
The primary distinction between pteridophytes and mosses (bryophytes) is the presence of a well-developed vascular system in the former. Pteridophytes possess true xylem and phloem, which are absent in mosses. This anatomical advancement allows pteridophytes to achieve greater height and structural complexity. Other features, such as the presence of archegonia and flagellate spermatozoids, are common to both groups. Additionally, while both have independent gametophytes, only in pteridophytes is the sporophyte the dominant and independent phase of the life cycle. Thus, the vascular system is their most significant differentiating characteristic.

138. (4) Pinus
From an evolutionary viewpoint, seed plants are considered more advanced than non-seed-bearing plants. Among the options provided, Pinus is a gymnosperm, which produces seeds and has a highly developed vascular system and a dominant sporophyte generation. In contrast, Selaginella is a pteridophyte, Funaria is a bryophyte, and Chlamydomonas is a unicellular alga, all of which represent more primitive stages of plant evolution. The development of the seed habit, as seen in Pinus, provides a significant advantage for reproduction and survival on land, making it the most evolutionary advanced.

139. (3) ovules not enclosed in ovary
The fundamental difference between Pinus (a gymnosperm) and mango (an angiosperm) lies in the protection of their ovules. In Pinus, the ovules are not enclosed within an ovary; they are borne naked on the surface of specialized leaves called megasporophylls, which are arranged in cones. In contrast, the ovules of a mango tree are enclosed within an ovary, which later develops into a fruit. While both are large trees with green leaves and wood, this "naked seed" versus

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"enclosed seed" characteristic is the primary taxonomic distinction between gymnosperms and angiosperms.

140. (4) Roots
Funaria is a moss (bryophyte) and Selaginella is a club moss (pteridophyte). While they share several primitive reproductive features, such as having archegonia and motile, flagellated sperms, they differ significantly in their vegetative anatomy. Selaginella possesses true roots for anchorage and absorption. In contrast, Funaria, like all bryophytes, lacks true roots and instead has hair-like structures called rhizoids. Both plants produce embryos during their life cycles, but the presence of actual roots is a more advanced characteristic found only in the vascular pteridophyte Selaginella and not in the bryophyte Funaria.

141. (3) Bryophyta
Bryophytes are a group of plants that produce spores and develop an embryo from a zygote, but they are characterized by the complete absence of true vascular tissues (xylem and phloem) and seeds. This combination of traits distinguishes them from other groups. Algae, like Rhodophyta and Phaeophyta, also lack vascular tissues and seeds but do not typically form a multicellular embryo within the parent plant. Pteridophytes possess vascular tissues but still reproduce via spores. Therefore, bryophytes represent the unique evolutionary stage where embryos are produced but a vascular system has not yet developed.

142. (2) Pinus
Resin and turpentine are economically important substances obtained primarily from various species of the genus Pinus. These gymnosperms possess specialized canals or ducts in their wood that produce and store resin as a defense mechanism against insects and pathogens. Turpentine is a volatile oil distilled from this resin and is widely used as a solvent in the paint and varnish industry. While other gymnosperms like Cedrus and Abies may also produce some resins, Pinus remains the most significant commercial source for both of these valuable plant-derived products.

143. (3) 6
In gymnosperms like Pinus, the endosperm is a haploid (n) tissue because it develops directly from the female gametophyte before fertilization. Since the pollen grain is also a haploid structure (n) representing the male gametophyte, it carries the same number of chromosomes as other haploid parts of the plant, including the endosperm. If a pollen grain has 6 chromosomes, then the haploid number n equals 6. Therefore, the endosperm cells will also contain exactly 6 chromosomes. This consistent haploid number across the gametophytic generation is a fundamental rule in gymnosperm genetics.

144. (4) gymnosperms.
Gymnosperms are a group of seed-producing plants that are distinguished by having naked seeds. Unlike angiosperms, they do not produce flowers or fruits. Their ovules and resulting seeds are borne directly on the scales of cones, exposed to the environment. Pteridophytes, mosses, and ferns do not produce seeds at all; they reproduce using spores. Therefore, any plant that possesses seeds but lacks the specialized protective and reproductive structures like flowers and fruits is classified as a gymnosperm. This group includes well-known trees such as pines, firs, and spruces.

145. (3) Chlamydomonas
In organisms with a haplontic life cycle, such as many green algae like Chlamydomonas, the dominant phase is the haploid gametophyte. The diploid sporophytic generation is extremely reduced and is represented solely by the single-celled zygote. Immediately after its formation through the fusion of gametes, the zygote undergoes meiosis to produce new haploid cells. In contrast, in plants like Pinus, Selaginella, and Dryopteris, the sporophyte is a complex, multicellular, and dominant part of the life cycle. Thus, Chlamydomonas is the correct example where the sporophyte stage is limited to the zygote.

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146. (3) gymnospermous wood
Turpentine is a valuable oleoresin and solvent that is primarily extracted from the wood and resin of certain gymnosperms, especially various species of pine trees. These plants have specialized resin ducts throughout their wood. When the wood is tapped or distilled, the raw resin is collected and then processed to produce turpentine and rosin. This substance is not obtained from angiosperms, bryophytes, or ferns in any commercial or significant quantity. Therefore, gymnospermous wood is the unique

and characteristic biological source for this widely used industrial and traditional material.

147. (1) isogamous
Chlamydomonas is a genus of unicellular green algae that exhibits various forms of sexual reproduction across its many species. However, the most common and typical mode found in many of its species is isogamy. In isogamous reproduction, the two gametes that fuse are morphologically identical in size, shape, and motility. While some specialized species of Chlamydomonas may show more advanced forms like anisogamy or oogamy, the basic and most frequently observed pattern in the genus remains the fusion of these similar-looking, flagellated gametes, which is a key feature in its reproductive biology.

148. (1) zygospore
In organisms like Spirogyra and Chlamydomonas, the fusion of two haploid gametes results in the formation of a diploid cell. This product of sexual reproduction is called a zygospore. The zygospore often develops a thick, protective wall, allowing it to survive harsh environmental conditions such as drought or cold. When conditions become favorable again, the zygospore undergoes meiosis to produce new haploid individuals. Other types of spores, like zoospores or carpospores, are typically involved in different stages of the life cycle or asexual reproduction, but the zygospore specifically follows gametic fusion.

149. (1) they require a layer of water for carrying out sexual reproduction
Bryophytes are known as the "amphibians of the plant kingdom" primarily because of their absolute requirement for external water during sexual reproduction. Although these plants can live on dry land, their motile male gametes (sperms) must have a thin film or layer of water to swim through to reach and fertilize the stationary egg in the archegonium. Without water, this transport and subsequent fertilization are impossible. While their preference for damp habitats and occasional aquatic nature are related, it is this specific reproductive dependency that most accurately defines their amphibious status in biology.

150. (4) Moss
Among the various groups of land plants, mosses (a type of bryophyte) possess the largest and most conspicuous gametophyte generation. In bryophytes, the gametophyte is the dominant, independent, and photosynthetic phase that forms the main body of the plant. In contrast, there is an evolutionary trend toward the reduction of the gametophyte in more advanced plants. In pteridophytes like Selaginella, the gametophyte is small and independent, while in seed plants like gymnosperms (Cycas) and angiosperms, the gametophytes are microscopic and entirely dependent on the sporophyte. Thus, mosses have the largest gametophytes.

151. (1) spore dispersal
The peristome is a specialized ring of teeth-like structures found at the opening of the capsule in many mosses. Its primary function is to regulate and aid in the dispersal of spores. These peristome teeth are hygroscopic, meaning they respond to changes in humidity by bending or twisting. As they move, they gradually release the spores from the capsule into the air currents, ensuring that the spores are spread over a wider area for successful colonization. This mechanism is crucial for the reproduction and survival of mosses, which lack other more active means of dispersal.

152. (1) lower part
The capsule of the moss Funaria is a complex structure divided into several distinct regions. The apophysis is the basal or lower part of the capsule where it connects to the stalk or seta. This region is notable because it contains photosynthetic tissue and stomata, allowing the sporophyte to produce some of its own food. Above the apophysis lies the fertile part of the capsule called the theca, where spores are produced. Therefore, the apophysis serves both as a structural connection and as a functional site for gas exchange and photosynthesis in the developing sporophyte.

153. (2) artificial system
Carolus Linnaeus, the father of modern taxonomy, developed a system of classification that is considered an artificial system. This is because his classification was primarily based on just one or a few observable morphological characteristics, specifically the reproductive organs of plants. He grouped plants according to the number and arrangement of their stamens and carpels, which is known as his sexual system. While this provided a convenient way to identify

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and name species, it did not necessarily reflect their overall natural similarities or evolutionary relationships, which are the goals of later natural and phylogenetic systems.

154. (3) Pliny the Edler
Artificial systems of classification are those that group organisms based on a few easily observable and often superficial characteristics. While Carolus Linnaeus developed the most famous artificial system, the earliest use of such a system can be traced back to ancient scholars. Pliny the Elder, a Roman naturalist, was one of the first to use an artificial approach to classify plants and animals based on their utility or habitat. Later scientists like De Candolle and Bentham and Hooker moved toward more natural systems that considered a broader range of traits to determine biological relationships between species.

155. (4) Pteris archegonia release chemical to attract its sperms.
In many non-vascular and primitive vascular plants, the movement of male gametes toward the female organs is guided by chemotaxis. When the archegonia of Pteris mature, they release specific chemical substances, such as malic acid or its salts, into the surrounding water. The sperms of Pteris are sensitive to these chemicals and swim along the concentration gradient toward the archegonia. Even if sperms of other plants like Funaria are present, they are generally not attracted by the same specific chemicals, ensuring that only the correct species' sperms reach and fertilize the eggs.

156. (1) heterosporous nature
Selaginella is a pteridophyte that exhibits several interesting morphological features, but its most evolutionary significant character is its heterosporous nature. Heterospory is the production of two distinct types of spores: large megaspores and small microspores. This condition is a vital precursor to the development of the seed habit because it leads to the specialization of male and female gametophytes. While rhizophores, strobili, and ligules are all characteristic of Selaginella, the transition from homospory to heterospory represents the most important step in the evolutionary history of land plants toward more complex seed-bearing forms.

157. (2) megaspore, pollen grain and endosperm
In gymnosperms like Pinus, the various parts of the plant have different ploidy levels depending on which generation they belong to. The megaspore is produced by meiosis and is therefore haploid (n). The pollen grain, which is the male gametophyte, is also haploid. Uniquely in gymnosperms, the endosperm develops from the haploid female gametophyte before fertilization, so it is also haploid. In contrast, tissues like the embryo, integument, roots, and leaves are part of the diploid (2n) sporophyte generation. Thus, megaspores, pollen grains, and endosperm correctly represent the haploid components.

158. (2) natural
The classification system proposed by George Bentham and Joseph Dalton Hooker is considered a natural system. This system is based on a wide range of observable morphological, anatomical, and embryological characteristics of plants. Instead of relying on just one or two traits, it considers the overall similarities and differences between organisms to determine their relationships. Published in their work "Genera Plantarum," this system became very influential and is still used in many herbaria today. It differs from artificial systems by using many characters and from phylogenetic systems by not primarily focusing on evolutionary history.

159. (1) isogamy
Sexual reproduction in the green alga Chlamydomonas frequently involves the fusion of two individual cells that act as gametes. When these two cells are morphologically identical in size, shape, and motility, the process is called isogamy. This is considered the most primitive form of sexual reproduction. In isogamy, it is not possible to distinguish between male and female gametes based on their appearance. While other forms of sexual reproduction like anisogamy and oogamy also occur in some species of Chlamydomonas, the simple fusion of identical-looking cells is the classic example of isogamy.

160. (2) haploid
In gymnosperms such as Pinus and Cycas, the endosperm is a nutritive tissue that develops from the female gametophyte before fertilization occurs. Since the female gametophyte itself is formed from a haploid megaspore through multiple rounds of mitosis, all its cells, including those that eventually form the endosperm,

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are haploid (n). This is a fundamental and characteristic difference from angiosperms, where the endosperm is typically a triploid (3n) tissue formed after double fertilization. Therefore, the haploid status of the endosperm is a consistent and identifying feature for all members of the gymnosperm group.

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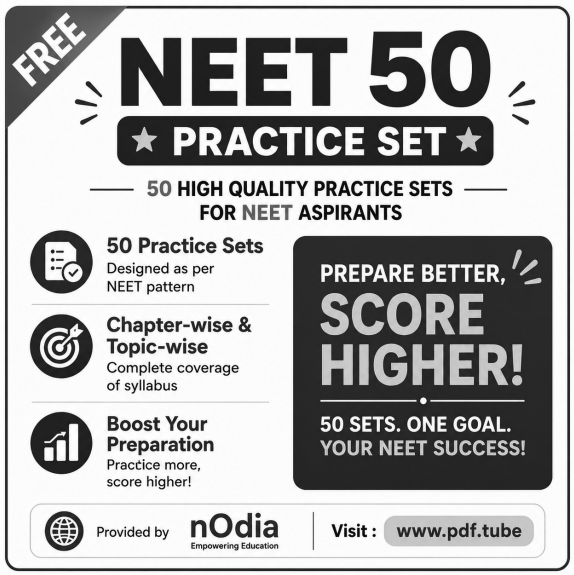

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CHAPTER 04
Animal Kingdom

2026 (RE-NEET)

1. Which of the following is not a characteristic of chordates?
(1) Absence of gills
(2) Presence of post anal part (tail)
(3) Presence of notochord
(4) Central nervous system is dorsal

2026 (RE-NEET)

2. Given below are two statements:
Statement I: The class name Reptilia refers to creeping or crawling locomotion.
Statement II: All organisms belonging to Reptilia have three chambered heart. Choose the most appropriate answer:
(1) Statement I is correct but Statement II is incorrect
(2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Both Statement I and Statement II are incorrect

2026 (RE-NEET)

3. In frogs, the number of pairs of cranial nerves arising from the brain are:
(1) 10
(2) 12
(3) 6
(4) 9

2026 (RE-NEET)

4. Given below are two statements
Statement I: When any plane through the central axis divides the organism into two identical halves, it is radial symmetry.
Statement II: In Echinodermata, both adults and larvae are radially symmetrical.
In the light of the above statements,choose the most appropriate answer from the options given below :
(1) Statement I is correct but Statement II is incorrect
(2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Both Statement I and Statement II are incorrect

2026 (RE-NEET)

5. Sponges exchange O_2 with CO_2 by:
(1) tracheal tubes
(2) gills
(3) simple diffusion over their entire body surfaces
(4) moist cuticle

2026 (CANCELLED)

6. Male frogs can be distinguished from female frogs due to the presence of:
A. Bulging eyes
B. Vocal sacs
C. Webbed digits in feet
D. Copulatory pad on first digit of fore limbs
E. Olive green-coloured skin with dark irregular spots
(1) B and C only
(2) C and E only
(3) A and B only
(4) B and D only

2026 (CANCELLED)

7. A group of researchers procured some fish-like animals and upon investigation the following characters were observed:
A. Endoskeleton was made of cartilage.
B. Ectoparasitic; as they were found attached to fish skin with their circular sucking mouth.
C. Paired fins and scales were absent, but 7 pairs of gill slits were present.
Which of the following species of animals did they consider to fit best with these characters
(1) Scoliodon sp.
(2) Petromyzon sp.
(3) Exocoetus sp.
(4) Branchiostoma sp.

2026 (CANCELLED)

8. Select the set of fishes which belong to the class Osteichthyes:
(1) Devil fish, Cuttlefish and Hagfish
(2) Saw fish, Fighting fish and Dog fish
(3) Star fish, Hagfish and Cuttlefish
(4) Flying fish, Angel fish and Fighting fish

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2026 (CANCELLED)

9. Select the INCORRECT statements from the following :

A. Digestive system in Platyhelminthes is incomplete.
B. Bilateral symmetry is a characteristic feature of adult Echinoderms.
C. Pseudocoelom is possessed by Aschelminthes.
D. Notochord is persistent throughout life in the class Chondrichthyes.
E. Members of class Reptilia maintain a constant body temperature.

(1) A and C only
(2) B and E only
(3) C and D only
(4) B and D only

2026 (CANCELLED)

10. Choose the correct statements regarding frog's anatomy:

A. Hepatic portal system is the special venous connection between liver and intestine.
B. There are twelve pairs of cranial nerves arising from the brain.
C. The ureters and oviducts open separately into the cloaca in female frogs.
D. Hind-brain consists of cerebellum, medulla oblongata and optic lobes.
E. Sinus venosus joins the right atrium of heart.

Choose the correct answer from the options given below

(1) A, B and C only
(2) B and D only
(3) B and C only
(4) A, C and E only

2026 (CANCELLED)

11. The flightless bird with forelimbs modified as paddle-like structures suited for swimming is known as:

(1) Struthio
(2) Neophron
(3) Aptenodytes
(4) Psittacula

2025

12. While trying to find out the characteristic of a newly found animal, a researcher did the histology of adult animal and observed a cavity with presence of mesodermal tissue towards the body wall but no mesodermal tissue was observed towards the alimentary canal. What could be the possible coelome of that animal?

(1) Schizocoelomate
(2) Spongocoelomate
(3) Acoelomate
(4) Pseudocoelomate

2025

13. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): All vertebrates are chordates but all chordates are not vertebrate.

Reason (R): The members of subphylum vertebrata possess notochord during the embryonic period, the notochord is replaced by a cartilaginous or bony vertebral column in adults.

In the light of the above statements, choose the correct answer from the options given below :

(1) A is true but R is false.
(2) A is false but R is true.
(3) Both A and R are true and R is the correct explanation of A.
(4) Both A and R are true but R is not the correct explanation of A.

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2025

14. All living members of the Class Cyclostomata are

(1) symbiotic
(2) ectoparasite
(3) free-living
(4) endoparasite.

2025

15. Role of the water vascular system in Echinoderms is:

A. Respiration and locomotion
B. Excretion and locomotion
C. Capture and transport of food
D. Digestion and respiration
E. Digestion and excretion

Choose the correct answer from the options given below.

(1) B and C Only
(2) B, D and E Only
(3) A and B Only
(4) A and C Only

RE-EXAM 2024

16. Which of the following pairs is an incorrect match?

(1) Annelids and arthropods - Bilateral symmetry
(2) Sponges - Acoelomates
(3) Coelenterates and Ctenophores - Radial symmetry
(4) Platyhelminthes - Diploblastic organisation

RE-EXAM 2024

17. Match List-I with List-II.

	List-I		List-II
A.	Chondrichthyes	I.	Clarias
B.	Cyclostomata	II.	Carcharodon
C.	Osteichthyes	III.	Myxine
D.	Amphibia	IV.	Ichthyophis

Choose the correct answer from the options given below.
(1) A-II, B-IV, C-I, D-III
(2) A-I, B-III, C-II, D-IV
(3) A-II, B-III, C-I, D-IV
(4) A-I, B-II, C-III, D-IV

RE-EXAM 2024

18. Open circulatory system is present in
(1) Palaemon, Nereis, Balanoglossus
(2) Hirudinaria, Bombyx, Salpa
(3) Anopheles, Limax, Limulus
(4) Pheretima, Musca, Pila.

2024

19. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Members of subphylum vertebrata possess notochord during the embryonic period. The notochord is replaced by a cartilaginous or bony vertebral column in the adult.
Reason (R) : Thus all chordates are vertebrates but not all vertebrates are chordates.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) A is true but R is false.
(2) A is false but R is true.
(3) Both A and R are true and R is the correct explanation of A.
(4) Both A and R are true but R is not the correct explanation of A.

2024

20. Consider the following statements.
A. Annelids are true coelomates.
B. Poriferans are pseudocoelomates.
C. Aschelminthes are acoelomates.
D. Platyhelminthes are pseudocoelomates.
Choose the correct answer from the options given below.
(1) B only (2) A only
(3) C only (4) D only

2024

21. Match List I with List II.

	List-I		List-II
A.	Pterophyllum	I.	Hag fish
B.	Myxine	II.	Saw fish
C.	Pristis	III.	Angel fish
D.	Exocoetus	IV.	Flying fish

Choose the correct answer from the options given below.
(1) A-II, B-I, C-III D-IV
(2) A-III, B-I, C-II, D-IV
(3) A-IV, B-I, C-II, D-III
(4) A-III, B-II, C-I, D-IV

2024

22. Match List I with List II.

	List-I		List-II
A.	Pleurobrachia	I.	Mollusca
B.	Radula	II.	Ctenophora
C.	Stomochord	III.	Osteichthyes
D.	Air bladder	IV.	Hemichordata

Choose the correct answer from the options given below.
(1) A-IV, B-II, C-III, D-I
(2) A-I, B-I, C-IV, D-III
(3) A-II, B-IV, C-I, D-III
(4) A-IV, B-III, C-II, D-I

2024

23. The following are the statements about non chordates :
A. Pharynx is perforated by gill slits.
B. Notochord is absent.
C. Central nervous system is dorsal.
D. Heart is dorsal if present.
E. Post anal tail is absent.
Choose the most appropriate answer from the options given below.
(1) A and C only
(2) A, B and D only
(3) B, D and E only
(4) B, C and D only

2023

24. Radial symmetry is not found in adults of phylum
(1) Coelenterata
(2) Echinodermata
(3) Ctenophora
(4) Hemichordata

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25. Select the correct statements.

A. Platyhelminthes are triploblastic pseudocoelomate and bilaterally symmetrical organisms.

B. Ctenophores reproduced only sexually and fertilisation is external.

C. In tapeworm, fertilisation is internal but sexes are not separate.

D. Ctenophores are exclusively marine diploblastic and bioluminescent organisms.

E. In sponges, fertilisation is external and development direct.

Choose the correct answer from the option given below.

(1) (A), (C) and (D) only
(2) (B), (C) and (D) only
(3) (A) and (E) only
(4) (B) and (D) only

Manipur NEET 2023

26. Match List I with List II.

	List-I		List-II
A.	Contractile vacuole	I.	Asterias
B.	Water vascular system	II.	Amoeba
C.	Canal system	III.	Spongilla
D.	Flame cells	IV.	Taenia

Choose the correct answer from the options given below.

(1) (A)-(IV), (B)-(II), (C)-(I), (D)-(III)
(2) (A)-(I), (B)-(III), (C)-(II), (D)-(IV)
(3) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)
(4) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)

2023

27. The unique mammalian characteristics are

(1) hairs, pinna and indirect development
(2) pinna, monocondylic skull and mammary glands
(3) hairs, tympanic membrane and mammary glands
(4) hairs, pinna and mammary glands.

2023

28. Select the correct statements with reference to chordates.

A. Presence of a mid-dorsal, solid and double nerve cord.

B. Presence of closed circulatory system.

C. Presence of paired pharyngeal gill slits

D. Presence of dorsal heart

E. Triploblastic pseudocoelomate animals.

Choose the correct answer from the options given below:

(1) B, D and E only
(2) C, D and E only
(3) A, C and D only
(4) B and C only

2022

29. Exoskeleton of arthropods is composed of

(1) cutin
(2) cellulose
(3) chitin
(4) glucosamine.

2022

30. In which of the following animals, digestive tract has additional chambers like crop and gizzard?

(1) Corvus, Columba, Chameleon
(2) Bufo, Balaenoptera, Bangarus
(3) Catla, Columba, Crocodilus
(4) Pavo, Psittacula, Corvus

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2022

31. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason(R).

Assertion (A) : All vertebrates are chordates but all chordates are not vertebrates.

Reason (R): Notochord is replaced by vertebral column in the adult vertebrates.

In the light of the above statements, choose appropriate answer from the options given below.

(1) Both (A) and (R) are correct and (R) is the correct explanation of (A)
(2) (A) is correct but (R) is not correct
(3) (A) is not correct but (R) is correct
(4) Both (A) and (R) are correct but (R) is incorrect explanation of (A)

2021

32. Match the following.

	List-I		List-II
(p)	Physalia	(i)	Pearl oyster
(q)	Limulus	(ii)	Portuguese man of war
(r)	Ancylostoma	(iii)	Living fossil
(s)	Pinctada	(iv)	Hookworm

Choose the correct answer from the options given below.

(1) (p)-(i), (q)-(iv), (r)-(iii), (s)-(ii)
(2) (p)-(ii), (q)-(iii), (r)-(i), (s)-(iv)
(3) (p)-(iv), (q)-(i), (r)-(iii), (s)-(ii)

(4) (p)-(ii), (q)-(iii), (r)-(iv), (s)-(i)

2021

33. Which one of the following organisms bears hollow and pneumatic long bones?
(1) Ornithorhynchus
(2) Neophron
(3) Hemidactylus
(4) Macropus

2021

34. Read the following statements.
A. Metagenesis is observed in helminths.
B. Echinoderms are triploblastic and coelomate animals.
C. Round worms have organ-system level of body organization.
D. Comb plates present in ctenophores help in digestion.
E. Water vascular system is characteristic of echidoderms.
Choose the correct answer from the options given below.
(1) (B), (C) and (E) are correct
(2) (C), (D) and (E) are correct
(3) (A), (B) and (C) are correct
(4) (A), (D) and (E) are correct

2021

35. Match List-I with List-II.

	List-I		List-II
(p)	Metamerism	(i)	Coelenterata
(q)	Canal system	(ii)	Ctenophora
(r)	Comb plates	(iii)	Annelida
(s)	Cnidoblasts	(iv)	Porifera

Choose the correct answer from the options given below.
(1) (p)-(iv), (q)-(i), (r)-(ii), (s)-(iii)
(2) (p)-(iv), (q)- (iii), (r)-(i), (s)-(ii)
(3) (p)-(iii), (q)-(iv), (r)-(i), (s)-(ii)
(4) (p)-(iii), (q)-(iv), (r)-(ii), (s)-(i)

2020

36. Bilaterally symmetrical and acoelomate animals are exemplified by
(1) ctenophora
(2) platyhelminthes
(3) aschelminthes
(4) annelida.

2020

37. Match the following columns and select the correct option.

	Column I		Column II
A.	6-15 pairs of gill slits	(i)	Trygon
B.	Heterocercal caudal fin	(ii)	Cyclostomes
C.	Air bladder	(iii)	Chondrichthyes
D.	Poison sting	(iv)	Osteichthyes

(1) (A)-(ii), (B)-(iii), (C)-(iv), (D)-(i)
(2) (A)-(iii), (B)-(iv), (C)-(i), (D)-(ii)
(3) (A)-(iv), (B)-(ii), (C)-(iii), (D)-(i)
(4) (A)-(i), (B)-(iv), (C)-(iii), (D)-(ii)

2020

38. Which of the following statements are true for the Phylum Chordata?
A. In Urochordata, notochord extends from head to tail and it is present throughout their life.
B. In Vertebrata, notochord is present during the embryonic period only.
C. Central nervous system is dorsal and hollow.
D. Chordata is divided into 3 subphyla : Hemichordata, Tunicata and Cephalochordata.
(1) (D) and (C)
(2) (C) and (A)
(3) (A) and (B)
(4) (B) and (C)

2020

39. Match the following columns and select the correct option.

	Column I		Column II
A.	Gregarious, polyphagous pest	(i)	Asterias
B.	Adult with radial symmetry and larva with bilateral symmetry	(ii)	Scorpion
C.	Book lungs	(iii)	Ctenoplana
D.	Bioluminescence	(iv)	Locusta

(1) (A)- (i), (B)-(iii), (C)-(ii), (D)-(iv)
(2) (A)- (iv), (B)-(i), (C)-(ii), (D)-(iii)
(3) (A)- (iii), (B)-(ii), (C)-(i), (D)-(iv)
(4) (A)- (ii), (B)-(i), (C)-(iii), (D)-(iv)

2019

40. Consider following features.
A. Organ system level of organisation
B. Bilateral symmetry

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C. True coelomates with segmentation of body
Select the correct option of animal groups which possess all the above characteristics.
(1) Annelida, Mollusca and Chordata
(2) Annelida, Arthropoda and Chordata
(3) Annelida, Arthropoda and Mollusca
(4) Arthropoda, Mollusca and Chordata

Odisha NEET 2019

41. Which of the following animals are true coelomates with bilateral symmetry?
(1) Adult Echinoderms
(2) Aschelminthes
(3) Platyhelminthes
(4) Annelids

2019

42. Match the following organisms with respective characteristics.

Column I (Organism)		Column II (Characteristics)	
A.	Pila	(i)	Flame cells
B.	Bombyx	(ii)	Comb plates
C.	Pleurobrachia	(iii)	Radula
D.	Taenia	(iv)	Malpighian tubules

Select the correct option from the following.
(1) (A)- (iii), (B)-(ii), (C)-(iv), (D)-(i)
(2) (A)- (iii), (B)-(ii), (C)-(i), (D)-(iv)
(3) (A)- (iii), (B)-(iv), (C)-(ii), (D)-(i)
(4) (A)- (ii), (B)-(iv), (C)-(iii), (D)-(i)

Odisha NEET 2019

43. Match the following genera with their respective phylum.

Column I (Genera)		Column II (Phylum)	
(1)	Ophiura	(i)	Mollusca
(2)	Physalia	(ii)	Platyhelminthes
(3)	Pinctada	(iii)	Echinodermata
(4)	Planaria	(iv)	Coelenterata

Select the correct option.
(1) (1)-(iv), (2)-(i), (3)-(iii), (4)-(ii)
(2) (1)-(iii), (2)-(iv), (3)-(i), (4)-(ii)
(3) (1)-(i), (2)-(iii), (3)-(iv), (4)-(ii)
(4) (1)-(iii), (2)-(iv), (3)-(ii), (4)-(i)

2018

44. Which of the following animals does not undergo metamorphosis?
(1) Earthworm (2) Tunicate
(3) Moth (4) Starfish

2018

45. Identify the vertebrate group of animals characterised by crop and gizzard in its digestive system.
(1) Amphibia
(2) Reptilia
(3) Aves
(4) Osteichthyes

2018

46. Which one of these animals is not a homeotherm?
(1) Macropus
(2) Chelone
(3) Camelus
(4) Psittacula

2017

47. Important characteristic that hemichordates share with chordates is
(1) ventral tubular nerve cord
(2) pharynx with gill slits
(3) pharynx without gill slits
(4) absence of notochord.

2017

48. Which among these is the correct combination of aquatic mammals?
(1) Dolphins, Seals, Trygon
(2) Whales, Dolphins, Seals
(3) Trygon, Whales, Seals
(4) Seals, Dolphins, Sharks

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2017

49. Which of the following represents order of 'Horse'?
(1) Perissodactyla
(2) Caballus
(3) Ferus
(4) Equidae

2017

50. In case of poriferans, the spongocoel is lined with flagellated cells called
(1) oscula
(2) choanocytes
(3) mesenchymal cells
(4) ostia.

NEET-II 2016

51. Choose the correct statement.
(1) All mammals are viviparous.
(2) All cyclostomes do not possess jaws and paired fins.
(3) All reptiles have a three-chambered heart.
(4) All pisces have gills covered by an operculum.

NEET-I 2016

52. Which one of the following characteristics is not shared by birds and mammals?
(1) Viviparity
(2) Warm blooded nature
(3) Ossified endoskeleton
(4) Breathing using lungs

NEET-I 2016

53. Which of the following characteristic features always holds true for the corresponding group of animals?
(1) Possess a mouth with an upper and a lower jaw : Chordata
(2) 3-chambered heart with one incompletely divided ventricle : Reptilia
(3) Cartilaginous endoskeleton : Chondrichthyes
(4) Viviparous : Mammalia

NEET-I 2016

54. Which of the following features is not present in the Phylum Arthropoda?
(1) Parapodia
(2) Jointed appendages
(3) Chitinous exoskeleton
(4) Metameric segmentation

2015

55. Body having meshwork of cells, internal cavities lined with food filtering flagellated cells and indirect development are the characteristics of Phylum
(1) Mollusca
(2) Protozoa
(3) Coelenterata
(4) Porifera.

2015

56. Metagenesis refers to
(1) occurrence of a drastic change in form during post-embryonic development
(2) presence of a segmented body and parthenogenetic mode of reproduction
(3) presence of different morphic forms
(4) alternation of generation between asexual and sexual phases of an organism.

2015

57. A jawless fish, which lays eggs in fresh water and whose ammocoetes larvae after metamorphosis return to the ocean is
(1) Neomyxine
(2) Petromyzon
(3) Eptatretus
(4) Myxine.

2015 Cancelled

58. Which of the following endoparasites of humans does show viviparity?
(1) Trichinella spiralis
(2) Ascaris lumbricoides
(3) Ancylostoma duodenale
(4) Enterobius vermicularis

2015 Cancelled

59. Which of the following represents the correct combination without any exception ?
(1) Characteristics: Sucking and circular mouth; jaws absent, integument without scales; paired appendages. Class: Cyclostomata
(2) Characteristics: Body covered with feathers; skin moist and glandular, fore-limbs form wings; lungs with air sacs. Class: Aves
(3) Characteristics: Mammary gland; hair on body; pinnae; two pairs of limbs. Class: Mammalia
(4) Characteristics: Mouth ventral; gills without operculum; skin with placoid scales; persistent notochord. Class: Chondrichthyes

2015 Cancelled

60. Which of the following animals is not viviparous?
(1) Platypus
(2) Whale
(3) Flying fox (Bat)
(4) Elephant

2015 Cancelled

61. Which of the following characteristics is mainly responsible for diversification of insects on land?
(1) Exoskeleton
(2) Eyes
(3) Segmentation
(4) Bilateral symmetry

2014

62. Select the taxon mentioned that represents both marine and fresh water species.
(1) Echinoderms
(2) Ctenophora
(3) Cephalochordata
(4) Cnidaria

2014

63. Planaria possesses high capacity of
(1) metamorphosis
(2) regeneration
(3) alternation of generation
(4) bioluminescence.

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2014

64. A marine cartilaginous fish that can produce electric current is
(1) Pristis (2) Torpedo
(3) Trygon (4) Scoliodon.

2013

65. Which of the following are correctly matched with respect to their taxonomic classification?

(1)	House fly, butterfly, tse-tse fly, silver fish	Insecta
(2)	Spiny anteater, sea urchin, sea cucumber	Echinodermata
(3)	Flying fish, cuttle fish, silver fish	Pisces
(4)	Centipede, millipede, spider, scorpion	Insecta

2013

66. Which group of animals belong to the same phylum?
(1) Prawn, Scorpion, Locusta
(2) Sponge, Sea anemone, Starfish
(3) Malarial parasite, Amoeba, Mosquito
(4) Earthworm, Pinworm, Tapeworm

2013

67. Match the name of the animal (column I), with one characteristic (column II) and the phylum/ class (column III) to which it belongs.

	Column I	**Column II**	**Column III**
(1)	Limulus	Body covered by chitinous exoskeleton	Pisces
(2)	Adamsia	Radially symmetrical	Porifera
(3)	Petromyzon	Ectoparasite	Cyclostomata
(4)	Ichthyophis	Terrestrial	Reptilia

2013

68. One of the representatives of Phylum Arthropoda is
(1) puffer fish (2) flying fish
(3) cuttle fish (4) silver fish.

Karnataka NEET 2013

69. The characteristics of Class Reptilia are
(1) body covered with moist skin which is devoid of scales, the ear is represented by a tympanum, alimentary canal, urinary and reproductive tracts open into a common cloaca
(2) fresh water animals with bony endoskeleton, air-bladder to regulate buoyancy
(3) marine animals with cartilaginous endoskeleton, body covered with placoid scales
(4) body covered with dry and cornified skin, scales over the body are epidermal, they do not have external ears.

Karnataka NEET 2013

70. Which one of the following groups of animals reproduces only by sexual means?
(1) Cnidaria (2) Porifera
(3) Protozoa (4) Ctenophora

Karnataka NEET 2013

71. Which one of the following animals is correctly matched with its one characteristic and the taxon?

	Animal	**Characteristic**	**Taxon**
(1)	Millipede	Ventral nerve cord	Arachnida
(2)	Sea anemone	Triploblastic	Cnidaria
(3)	Silver fish	Pectoral and pelvic fins	Chordata
(4)	Duckbilled platypus	Oviparous	Mammalia

Karnataka NEET 2013

72. Sharks and dogfishes differ from skates and rays because
(1) gill slits are ventrally placed
(2) head and trunk are widened considerably
(3) distinct demarcation between body and tail
(4) their pectoral fins distinctly marked off from cylindrical bodies.

NODIA

2012

73. In which one of the following, the genus name, its two characters and its phylum are not correctly matched, whereas the remaining three are correct?

(1)	Pila	(i) Body segmented (ii) Mouth with radula	Mollusca
(2)	Asterias	(i) Spiny skinned (ii) Water vascular system	Echinodermata
(3)	Sycon	(i) Pore bearing (ii) Canal system	Porifera
(4)	Periplaneta	(i) Jointed appendages (ii) Chitinous exoskeleton	Arthropoda

Mains 2012

74. Which one of the following pairs of animals are similar to each other pertaining to the feature stated against them?
(1) Pteropus and Ornithorhynchus - Viviparity
(2) Garden lizard and crocodile - Three chambered heart
(3) Ascaris and Ancylostoma - Metameric segmentation
(4) Sea horse and flying fish - Cold blooded (poikilothermal)

Mains 2012

75. Which one of the following categories of animals, is correctly described with no single exception in it?
(1) All reptiles possess scales, have a three chambered heart and are cold blooded (poikilothermal).
(2) All bony fishes have four pairs of gills and an operculum on each side.
(3) All sponges are marine and have collared cells.
(4) All mammals are viviparous and possess diaphragm for breathing.

2011

76. What will you look for to identify the sex of the following?
(1) Female Ascaris-sharply curved posterior end
(2) Male frog- a copulatory pad on the first digit of the hind limb
(3) Female cockroach-anal cerci
(4) Male shark-claspers borne on pelvic fins

2011

77. Which one of the following groups of animals is correctly matched with its characteristic feature without any exception?
(1) Reptilia : possess 3-chambered heart with an incompletely divided ventricle
(2) Chordata : possess a mouth with an upper and a lower jaw
(3) Chondrichthyes : possess cartilaginous endoskeleton
(4) Mammalia : give birth to young ones

2011

78. In which one of the following the genus name, its two characters and its class/phylum are correctly matched?

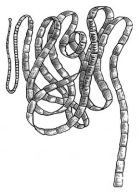
	Genus Name	**Two Characters**	**Class/Phylum**
(1)	Ascaris	(i) Body segmented (ii) Males and females distinct	Annelida
(2)	Salamandra	(i) A tympanum represents ear (ii) Fertilization is external	Amphibia
(3)	Pteropus	(i) Skin possesses hair (ii) Oviparous	Mammalia
(4)	Aurelia	(i) Cnidoblasts (ii) Organ level of organization	Coelenterata

Mains 2011

79. Which one of the following statements is totally wrong about the occurrence of notochord, while the other three are correct?
(1) It is present only in larval tail in ascidian.
(2) It is replaced by a vertebral column in adult frog.
(3) It is absent throughout life in humans from the very beginning.
(4) It is present throughout life in Amphioxus.

Mains 2011

80. The figures (A - D) show four animals. Select the correct option with respect to a common characteristic of two of these animals.

(A)  (B)

(C) (D)

(1) (A) and (D) respire mainly through body wall.
(2) (B) and (C) show radial symmetry.
(3) (A) and (B) have cnidoblasts for self-defence.
(4) (C) and (D) have a true coelom.

2010

81. Which one of the following kinds of animals are triploblastic?
(1) Flatworms (2) Sponges
(3) Ctenophores (4) Corals

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2010

82. Which one of the following statements about certain given animals is correct?
(1) Roundworms (Aschelminthes) are pseudocoelomates.
(2) Molluscs are acoelomates.
(3) Insects are pseudocoelomates.
(4) Flatworms (Platyhelminthes) are coelomates.

2010

83. One example of animals having a single opening to the outside that serves both as mouth as well as anus is
(1) Octopus
(2) Asterias
(3) Ascidia
(4) Fasciola.

2010

84. Which one of the following statements about all the four of Spongilla, leech, dolphin and penguin is correct?
(1) Penguin is homoiothermic while the remaining three are poikilothermic.
(2) Leech is a fresh water form while all others are marine.
(3) Spongilla has special collared cells called choanocytes, not found in the remaining three.
(4) All are bilaterally symmetrical.

Mains 2010

85. In which one of the following organisms its excretory organs are correctly stated?
(1) Humans - Kidneys, sebaceous glands and tear glands
(2) Earthworm - Pharyngeal, integumentary and septal nephridia
(3) Cockroach - Malpighian tubules and enteric caeca
(4) Frog - Kidneys, skin and buccal epithelium

Mains 2010

86. Crocodile and penguin are similar to whale and dogfish in which one of the following features?
(1) Possess a solid single stranded central nervous system
(2) Lay eggs and guard them till they hatch
(3) Possess bony skeleton
(4) Have gill slits at some stage

2009

87. Which one of the following groups of animals is bilaterally symmetrical and triploblastic?
(1) Aschelminthes (roundworms)
(2) Ctenophores
(3) Sponges
(4) Coelenterates (cnidarians)

2009

88. Which one of the following pairs of animals comprises 'jawless fishes'?
(1) Mackerals and rohu
(2) Lampreys and hag fishes
(3) Guppies and hag fishes
(4) Lampreys and eels

2008

89. Which one of the following in birds, indicates their reptilian ancestry?
(1) Two special chambers crop and gizzard in their digestive tract
(2) Eggs with a calcareous shell
(3) Scales on their hind limbs
(4) Four-chambered heart

2008

90. Ascaris is characterized by
(1) presence of true coelom but absence of metamerism
(2) presence of true coelom and metamerism (metamerisation)
(3) absence of true coelom but presence of metamerism
(4) presence of neither true coelom nor metamerism.

2008

91. Which one of the following groups of three animals each is correctly matched with their one characteristic morphological feature?

	Animals	**Morphological Features**
(1)	Scorpion, spider, cockroach	Ventral solid central nervous system
(2)	Cockroach, locust, Taenia	Metameric segmentation
(3)	Liver fluke, sea anemone, sea cucumber	Bilateral symmetry
(4)	Centipede, prawn, sea urchin	Jointed appendages

2008

92. Which one of the following phyla is correctly matched with its two general characteristics?
(1) Echinodermata - pentamerous radial symmetry and mostly internal fertilization
(2) Mollusca - normally oviparous and development through a trochophore or veliger larva
(3) Arthropoda - body divided into head, thorax and abdomen and respiration by tracheae

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(4) Chordata - notochord at some stage and separate anal and urinary openings to the outside.

2008

93. Which one of the following is not a characteristic of Phylum Annelida?
(1) Pseudocoelom
(2) Ventral nerve cord
(3) Closed circulatory system
(4) Segmentation

2007

94. Which of the following pairs are correctly matched?

	Animals	**Morphological Features**
(i)	Crocodile	4-chambered heart
(ii)	Sea urchin	Parapodia
(iii)	Obelia	Metagenesis
(iv)	Lemur	Thecodont

(1) (ii), (iii) and (iv)
(2) only (i) and (iv)
(3) only (i) and (ii)
(4) (i), (iii) and (iv)

2007

95. Which one of the following is a matching pair of a body feature and the animal possessing it?
(1) Ventral central nervous system - Leech
(2) Pharyngeal gill slits absent in embryo - Chamaeleon
(3) Ventral heart - Scorpion
(4) Post-anal tail - Octopus

2007

96. What is common between parrot, platypus and kangaroo?
(1) Toothless jaws
(2) Functional post-anal tail
(3) Ovoparity
(4) Homoiothermy

2007

97. What is true about Nereis, scorpion, cockroach and silver fish?
(1) They all possess dorsal heart.
(2) None of them is aquatic.
(3) They all belong to the same phylum.
(4) They all have jointed paired appendages.

2006

98. Metameric segmentation is the characteristic of
(1) mollusca and chordata
(2) platyhelminthes and arthropoda
(3) echinodermata and annelida
(4) annelida and arthropoda.

2006

99. Biradial symmetry and lack of cnidoblasts are the characteristics of
(1) Hydra and starfish
(2) Starfish and sea anemone
(3) Ctenoplana and Beroe
(4) Aurelia and Paramecium.

2006

100. Two common characters found in centipede, cockroach and crab are
(1) book lungs and antennae
(2) compound eyes and anal cerci
(3) jointed legs and chitinous exoskeleton
(4) green gland and tracheae.

2006

101. In which one of the following sets of animals do all the four give birth to young ones?
(1) Kangaroo, hedgehog, dolphin, Loris
(2) Lion, bat, whale, ostrich
(3) Platypus, penguin, bat, hippopotamus
(4) Shrew, bat, cat, kiwi

NODIA

2006

102. Which one of the following is a matching set of a phylum and its three examples?
(1) Porifera - Spongilla, Euplectella, Pennatula
(2) Cnidaria - Bonellia, Physalia, Aurelia
(3) Platyhelminthes - Planaria, Schistosoma, Enterobius
(4) Mollusca - Loligo, Teredo, Octopus

2006

103. What is common about Trypanosoma, Noctiluca, Monocystis and Giardia ?
(1) These are all parasities.
(2) These are all unicellular protists.
(3) They have flagella.
(4) They produce spores.

2005

104. In contrast to annelids the platyhelminthes show
(1) absence of body cavity
(2) bilateral symmetry
(3) radial symmetry
(4) presence of pseudocoel.

2005

105. From the following statements select the wrong one.
(1) Prawn has two pairs of antennae.
(2) Nematocysts are characteristics of the Phylum Cnidaria.

(3) Millepedes have two pairs of appendages in each segment of the body.
(4) Animals belonging to Phylum Porifera are marine and fresh water.

2005

106. Which one of the following characters is not typical of the Class Mammalia?
(1) Thecodont dentition
(2) Alveolar lungs
(3) Ten pairs of cranial nerves
(4) Seven cervical vertebrae

2004

107. The animals with bilateral symmetry in young stage and radial pentamerous symmetry in the adult stage, belong to the Phylum
(1) Annelida
(2) Mollusca
(3) Cnidaria
(4) Echinodermata.

2004

108. In arthropoda, head and thorax are often used to form cephalothorax, but in which one of the following classes, is the body divided into head thorax and abdomen?
(1) Insecta
(2) Myriapoda
(3) Crustacea
(4) Arachnida and crustacea

2004

109. Presence of gills in the tadpole of frog indicates that
(1) fish were amphibious in the past
(2) fish evolved from frog-like ancestors
(3) frogs will have gills in future
(4) frogs evolved from gilled ancestors.

2004

110. One of the following is a very unique feature of the mammalian body
(1) homeothermy
(2) presence of diaphragm
(3) four chambered heart
(4) rib cage.

2003

111. Sycon belongs to a group of animals, which are best described as
(1) unicellular or acellular
(2) multicellular without any tissue organization
(3) multicellular with a gastrovascular system
(4) multicellular having tissue organization, but no body cavity.

2003

112. During the life-cycle, Fasciola hepatica (liver fluke) infects its intermediate host and primary host at the following larval stages respectively
(1) redia and miracidium
(2) cercaria and redia
(3) metacercaria and cercaria
(4) miracidium and metacercaria.

2003

113. Ommatidia serve the purpose of photoreception in
(1) cockroach
(2) frog
(3) humans
(4) sunflower.

2003

114. Which one of the following is a matching pair of an animal and a certain phenomenon it exhibits?
(1) Pheretima - Sexual dimorphism
(2) Musca - Complete metamorphosis
(3) Chameleon - Mimicry
(4) Taenia - Polymorphism

2003

115. Given below are four matchings of an animal and its kind of respiratory organ :
A. Silver fish - Trachea
B. Scorpion - Book lung
C. Sea squirt - Pharyngeal slits
D. Dolphin - Skin
The correct matching are
(1) (A) and (B)
(2) (A), (B) and (C)
(3) (B) and (D)
(4) (C) and (D).

2002

116. In which of the following animals nerve cell is present but brain is absent?
(1) Sponge
(2) Earthworm
(3) Cockroach
(4) Hydra

2002

117. In which of the following, notochord is present in embryonic stage?
(1) All chordates
(2) Some chordates
(3) Vertebrates
(4) Non chordates

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2001

118. In which of the following animals, haemocyanin pigment is found?
(1) Annelida
(2) Echinodermata
(3) Insecta
(4) Mollusca

2001

119. In which of the following animals post anal tail is found?
(1) Earthworm
(2) Lower invertebrates
(3) Scorpion
(4) Snake

2001

120. In Hydra, waste material of food digestion and nitrogenous waste material are removed respectively from
(1) mouth and mouth
(2) body wall and body wall
(3) mouth and body wall
(4) mouth and tentacles.

2000

121. Which of the following animals have scattered cells with cell - tissue grade organisation?
(1) Sponge
(2) Hydra
(3) Liver fluke
(4) Ascaris

2000

122. Cleavage in mammals is
(1) holoblastic equal
(2) holoblastic unequal
(3) superficial
(4) discoidal.

2000

123. Similarity in Ascaris lumbricoides and Anopheles stephensi is
(1) sexual dimorphism
(2) metamerism
(3) anaerobic respiration
(4) endoparasitism.

2000

124. Which of the following characters is absent in all chordates?
(1) Diaphragm
(2) Coelom
(3) Pharyngeal gill clefts
(4) Dorsal nerve cord

2000

125. What is true for mammalia?
(1) Platypus is oviparous.
(2) Bats have feather.
(3) Elephant is ovoviviparous.
(4) Diaphragm is absent in them.

1999

126. Aquatic reptiles are
(1) ureotelic
(2) ureotelic in water
(3) ammonotelic
(4) ureotelic over land.

1999

127. Temperature changes, in the environment, affect most of the animals which are
(1) poikilothermic
(2) homoiothermic
(3) aquatic
(4) desert living.

1999

128. The canal system is a characteristic feature of
(1) echinoderms
(2) sponges
(3) helminthes
(4) coelenterates.

1999

129. Which of the following is not found in birds?
(1) Pelvic girdle
(2) Pectoral girdle
(3) Hindlimb
(4) Forelimb

1998

130. The long bones are hollow and connected by air passages. They are the characteristics of
(1) reptilia
(2) land vertebrates
(3) aves
(4) mammals.

NODIA

1998

131. Solenocytes are the main excretory structures in
(1) echinodermates
(2) platyhelminthes
(3) annelids
(4) molluscs.

1998

132. Most appropriate term to describe the life cycle of Obelia is
(1) metamorphosis
(2) neoteny
(3) metagenesis
(4) all of these.

1998

133. The lower jaw in mammals is made up of
(1) dentary
(2) maxilla
(3) angulars
(4) mandible.

1998

134. Which one of the following cells, found in testes of rabbit, secretes male hormone?
(1) Epithelial cells
(2) Spermatocytes
(3) Leydig's cell
(4) Sertoli cells

1997

135. What is common among silverfish, scorpion, crab and honey bee?
(1) Jointed legs
(2) Metamorphosis
(3) Compound eyes
(4) Poison glands

1997

136. The embryonated egg of Ascaris represents
(1) an egg with blastula
(2) an egg with a juvenile
(3) an egg with an egg
(4) an egg with gastrula.

1996

137. Coelom is found between
(1) body wall and ectoderm
(2) ectoderm and endoderm
(3) mesoderm and body wall (endoderm)
(4) mesoderm and ectoderm.

1996

138. Which of the following statements is without exception for sponges?
(1) They all have calcareous spicules.
(2) They have high regenerative power.
(3) They are found only in marine water.
(4) They are all radially symmetrical.

1996

139. Pneumatic bone is found in
(1) shark (2) Rana
(3) pigeon (4) whale.

1996

140. The nephridia in earthworm are analogous to
(1) nematoblasts of Hydra
(2) flame cells of Planaria
(3) gills of prawn
(4) trachea of insects.

1996

141. Which of the following is common among mammals?
(1) They undergo no moulting.
(2) They have seven cervical vertebrae.
(3) They are carnivores.
(4) They have ventral nerve cord.

1996

142. The formation of canal system in sponges is due to
(1) folding of inner walls
(2) gastro-vascular system
(3) reproduction
(4) porous walls.

1995

143. Besides annelida and arthropoda, the metamerism is exhibited by
(1) mollusca
(2) acanthocephala
(3) cestoda
(4) chordata.

1995

144. The organisms attached to the substratum, generally, possess
(1) one single opening of the digestive canal
(2) cilia on the surface to create water current
(3) radial symmetry
(4) asymmetrical body.

1994

145. A common characteristic of all vertebrates without exception is
(1) the division of body into head, neck, trunk and tail
(2) their body covered with an exoskeleton
(3) the possession of two pairs of functional appendages
(4) the presence of well-developed skull.

1994

146. One of the special characters of coelenterata only is the occurrence of
(1) polymorphism
(2) flame cells
(3) hermaphroditism
(4) nematocysts.

1994

147. Radial symmetry is, usually, exhibited in animals which
(1) are attached to the substratum
(2) have one opening of alimentary canal
(3) live in water
(4) have ciliary mode of feeding.

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1994

148. Which of the following is an example of platyhelminthes?
(1) Plasmodium
(2) Schistosoma
(3) Trypanosoma
(4) Wuchereria

1994

149. Among the following organisms point out a completely non-parasitic form
(1) Tapeworm
(2) Mosquito
(3) Sea anemone
(4) Leech.

1994

150. Tube feet are the characteristic structures of
(1) starfish
(2) jellyfish
(3) crayfish
(4) cuttlefish.

1994

151. Which of the following does not have an open circulatory system?
(1) Frog's tadpole
(2) Prawn
(3) Chelifer
(4) Cockroach

1993

152. Which is common between ostrich, penguin and kiwi?
(1) Running birds
(2) Migratory birds
(3) Flightless birds
(4) Four toed birds

1993

153. Which one assists in locomotion?
(1) Trichocysts in Paramecium
(2) Pedicellariae of starfish
(3) Clitellum in Pheretima
(4) Posterior sucker in Hirudinaria

1993

154. What is true about Taenia saginata?
(1) Life history has pig as intermediate host.
(2) There are two large suckers on scolex.
(3) Rostellar hooks are absent.
(4) Rostellum has double circle of hooks.

1993

155. Which one of the following animals possesses nerve cells but no nerves?
(1) Hydra
(2) Tapeworm
(3) Earthworm
(4) Frog's tadpole

1993

156. Budding is a normal mode of asexual reproduction in
(1) starfish and Hydra
(2) Hydra and sponges
(3) tapeworm and Hydra
(4) sponge and starfish.

1993

157. Tracheae of cockroach and mammal are similar in having
(1) paired nature
(2) noncollapsible walls
(3) ciliated inner lining
(4) origin from head.

1993

158. A larval stage occurs in the life history of all members of the group
(1) frog, lizard and cockroach
(2) Ascaris, housefly and frog
(3) housefly, earthworm and mosquito
(4) butterfly, frog and mosquito.

1993

159. Gorilla, chimpanzee, monkeys and humans belong to the same
(1) species (2) genus
(3) family (4) order.

1993

160. What is common in whale, bat and rat?
(1) Absence of neck
(2) Muscular diaphragm between thorax and abdomen
(3) Extra-abdominal testes to avoid high temperature of body
(4) Presence of external ears

1992

161. Aristotle's lantern occurs in Class
(1) Echinoidea (2) Asteroidea
(3) Holothuroidea (4) Ophiuroidea.

1992

162. Starfish belongs to
(1) asteriodea
(2) ophiuroidea
(3) holothuroidea
(4) crinoidea.

NODIA

1992

163. Eye of the molluscan group that resembles vertebrate eye is
(1) bivalvia
(2) gastropoda
(3) pelecypoda
(4) cephalopoda.

1992

164. Adult Culex and Anopheles can be distinguished with the help of
(1) mouth parts/colour
(2) sitting posture
(3) antennae/wings
(4) feeding habits.

1992

165. Sound box of birds is called
(1) pygostyle (2) larynx
(3) syrinx (4) synsacrum.

1992

166. Ascaris larva is called
(1) cysticercus
(2) rhabditiform
(3) hexacanth
(4) onchosphere.

1992

167. What is correct about Taenia?
(1) Male organs occur in posterior proglottides.
(2) Male organs occur in anterior proglottides.
(3) Female organs occur in anterior proglottides.
(4) Mature proglottides contain both male and female organs.

1992

168. The simplest type of canal system in porifera is
(1) ascon type
(2) leucon type
(3) sycon type
(4) radial type.

1992

169. An egg laying mammal is
(1) kangaroo
(2) platypus
(3) koala
(4) whale.

1992

170. Kidney of adult rabbit is
(1) pronephros
(2) metanephros
(3) mesonephros
(4) opisthonephros.

1991

171. Which one occurs in echinodermata?
(1) Bilateral symmetry
(2) Radial symmetry
(3) Porous body
(4) Soft skin

1991

172. An insect regarded as greatest mechanical carrier of diseases is
(1) Pediculus
(2) Cimex
(3) Musca
(4) Xenopsylla.

1991

173. Metamorphosis of insects is regulated through hormone
(1) pheromone
(2) thyroxine
(3) ecdysone
(4) all of these.

1991

174. Classification of Porifera is based on
(1) branching
(2) spicules
(3) reproduction
(4) symmetry.

1991

175. The excretory structures of flatworms/ Taenia are
(1) flame cells
(2) protonephridia
(3) Malpighian tubules
(4) green glands.

1991

176. Bladderworm/cysticercus is the larval stage of
(1) tapeworm
(2) roundworm
(3) pinworm
(4) liver fluke.

1990

177. Ecdysis is shedding of
(1) stratum corneum
(2) epidermis
(3) dermis
(4) stratum malpighi.

1990

178. Penguin occurs in
(1) Australia (2) Antarctica
(3) Africa (4) America.

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1990

179. Kala-azar and Oriental Sore are spread by
(1) housefly
(2) bed bug
(3) sand fly
(4) fruit fly.

1990

180. Malpighian tubules are
(1) excretory organs of insects
(2) excretory organs of annelids
(3) respiratory organs of insects
(4) respiratory organs of annelids.

1990

181. Taenia saginata differs from Taenia solium in
(1) absence of scolex hooks
(2) absence of scolex hooks and uterine branching
(3) absence of scolex hooks and presence of both male and female reproductive organs
(4) presence of scolex hooks.

1990

182. Onchosphere occurs in
(1) Ascaris
(2) Fasciola
(3) Taenia
(4) Planaria.

1989

183. Eutherians are characterised by
(1) hairy skin
(2) true placentation
(3) ovoviviparity
(4) glandular skin.

1989

184. Wish bone of birds is from
(1) pelvic girdle
(2) skull
(3) hind limbs
(4) pectoral girdle/clavicles.

1989

185. Flight muscles of bird are attached to
(1) clavicle
(2) keel of sternum
(3) scapula
(4) coracoid.

1989

186. A chordate character is
(1) gills
(2) spiracles
(3) post-anal tail
(4) chitinous exoskeleton.

1989

187. Transfer of Taenia to secondary host occurs as
(1) oncosphere
(2) cysticercus
(3) morula
(4) egg.

1989

188. Jelly fish belongs to Class
(1) Hydrozoa
(2) Scyphozoa
(3) Anthozoa
(4) none of these.

NODIA

1989

189. Fish which can be used in biological control of mosquitoes/larvicidal fish is
(1) Eel
(2) carp
(3) cat fish
(4) Gambusia.

1988

190. Hair occur in all mammals except those of
(1) rodentia
(2) chiroptera
(3) primata
(4) cetacea.

1988

191. Bird vertebrae are
(1) acoelous
(2) heterocoelous
(3) amphicoelous
(4) procoelous.

1988

192. Feet of kingfisher are modified for
(1) wading
(2) perching
(3) running
(4) catching.

1988

193. Both male and female pigeons secrete milk through
(1) salivary glands
(2) modified sweat glands
(3) crop
(4) gizzard.

1988

194. Typhlops is
(1) sea snake
(2) glass snake
(3) blind snake
(4) grass snake.

1988

195. Necturus is
(1) hell bender
(2) congo eel
(3) mud puppy
(4) blind worm.

1988

196. Fire bellied toad is
(1) Amphiuma
(2) Bombina
(3) Necturus
(4) Salamandra.

1988

197. Which is not a true amphibian animal?
(1) Salamander
(2) Toad
(3) Tortoise
(4) Frog

1988

198. A wood boring mollusc/shipworm is
(1) Chiton
(2) Teredo
(3) Limax
(4) Patella.

1988

199. Organ Pipe Coral is
(1) Tubipora
(2) Astraea
(3) Helipora
(4) Fungia.

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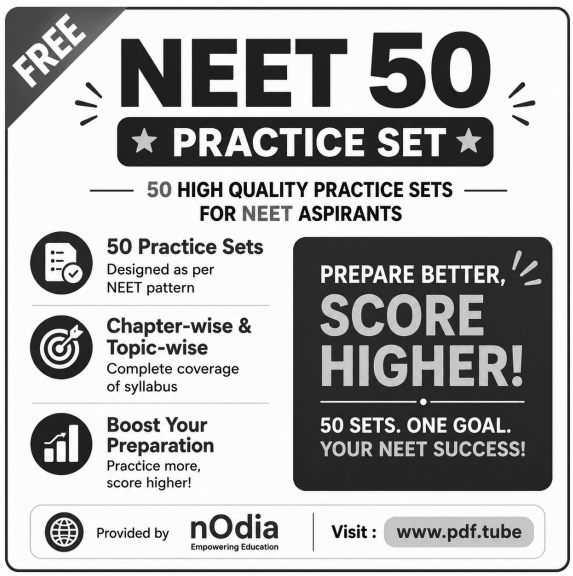

ANSWERS

1. (1) Absence of gills
The four fundamental chordate characters are a notochord, dorsal hollow nerve cord, paired pharyngeal gill slits, and a post-anal tail. Presence of pharyngeal gill slits is a defining feature, so 'absence of gills' is not a characteristic of chordates.

2. (1) Statement I is correct but Statement II is incorrect
The name Reptilia derives from creeping or crawling locomotion, so Statement I is correct. Most reptiles have a three-chambered heart, but crocodiles possess a four-chambered heart. Hence not all reptiles have a three-chambered heart, making Statement II incorrect.

3. (1) 10
In frogs, ten pairs of cranial nerves arise from the brain to supply different parts of the head and body. This is a characteristic feature of amphibians. Mammals, including humans, have twelve pairs, but frogs have only ten pairs.

4. (1) Statement I is correct but Statement II is incorrect
Radial symmetry is correctly defined (Statement I correct). In echinoderms, adults are radially symmetrical but larvae are bilaterally symmetrical. Hence both adults and larvae are not radially symmetrical, making Statement II incorrect.

5. (3) simple diffusion over their entire body surfaces
Sponges are simple multicellular animals lacking specialised respiratory organs. They exchange gases by simple diffusion across the entire body surface, with water flowing through their pores and canals supplying oxygen to the cells.

6. (4) B and D only
Male frogs possess vocal sacs used to amplify their croaking and copulatory (nuptial) pads on the first digit of the forelimbs for gripping the female during amplexus. Bulging eyes, webbed feet and olive-green skin with dark spots are common to both sexes, so only B and D distinguish males.

7. (2) Petromyzon sp.
Petromyzon (lamprey) is a jawless cyclostome with a cartilaginous endoskeleton, a circular sucking mouth, and an ectoparasitic habit on other fishes. It lacks paired fins and scales and possesses several pairs of gill slits. These features match all the observed characters, identifying it as Petromyzon.

8. (4) Flying fish, Angel fish and Fighting fish
Osteichthyes are bony fishes. Flying fish (Exocoetus), Angel fish (Pterophyllum) and Fighting fish (Betta) are all bony fishes. The other sets contain non-bony fishes like dog fish and saw fish (cartilaginous), hagfish (cyclostome), or non-fishes like cuttlefish, devil fish and star fish.

9. (2) B and E only
Adult echinoderms show radial symmetry, not bilateral, so B is incorrect. Reptiles are cold-blooded (poikilothermic) and cannot maintain constant body temperature, so E is incorrect. Statements A, C and D are correct about flatworm digestion, aschelminth pseudocoelom and persistent notochord in cartilaginous fishes.

10. (4) A, C and E only
The hepatic portal system connects intestine and liver (A correct). In female frogs, ureters and oviducts open separately into the cloaca (C correct). Sinus venosus joins the right atrium (E correct). Frogs have ten pairs of cranial nerves (B wrong), and optic lobes belong to the mid-brain, not hind-brain (D wrong).

11. (3) Aptenodytes
Aptenodytes is the genus of penguins, which are flightless birds whose forelimbs are modified into paddle-like flippers for swimming. Struthio is the ostrich (running bird), Neophron is a vulture, and Psittacula is a parrot, none of which have paddle-like swimming forelimbs, so Aptenodytes is correct.

12. (4) Pseudocoelomate
In some animals, the body cavity is not lined by mesoderm; instead, the mesoderm is present as scattered pouches between the ectoderm and endoderm. This specific arrangement defines a

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pseudocoelom. This characteristic is found in Aschelminthes, differentiating them from true coelomates.

13. (3) Both A and R are true and R is the correct explanation of A.
Vertebrates constitute a subphylum within the phylum Chordata. All members possess a notochord during their embryonic development. However, in vertebrates, this notochord is replaced by a cartilaginous or bony vertebral column in the adult stage. Consequently, while all vertebrates are fundamentally chordates, not all chordates belong to the vertebrate group as some retain the notochord.

14. (2) ectoparasite
Members of the class Cyclostomata, which includes lampreys and hagfishes, are primitive jawless vertebrates. All living species in this group are ectoparasites on certain fishes. They possess a circular and suctorial mouth without jaws, which allows them to attach to the body of their host fishes to feed on their blood and tissue fluids throughout their adult life.

15. (4) A and C Only
The water vascular system is the most distinctive feature of echinoderms. This system consists of a network of fluid-filled canals that play several vital roles. It facilitates locomotion via tube feet, assists in the capture and transport of food to the mouth, and is essentially involved in respiration. However, it does not primarily handle digestion or nitrogenous excretion.

16. (4) Platyhelminthes - Diploblastic organisation
Platyhelminthes are triploblastic animals, meaning they develop from three germ layers: ectoderm, mesoderm, and endoderm. This characteristic sets them apart from diploblastic organisms like coelenterates and ctenophores, which only possess two layers. Additionally, while sponges lack a true body cavity, they are functionally acoelomates, and annelids along with arthropods exhibit bilateral symmetry as a fundamental part of their body plan.

17. (3) A-II, B-III, C-I, D-IV
Classification of chordates involves matching specific organisms to their respective groups. Carcharodon is a member of Chondrichthyes, characterized by a cartilaginous skeleton. Myxine, also known as hagfish, belongs to Cyclostomata. Clarias is a bony fish classified under Osteichthyes. Ichthyophis is a limbless amphibian representing the class Amphibia. These pairings accurately reflect the biological diversity found within the different vertebrate subphyla.

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18. (3) Anopheles, Limax, Limulus
An open circulatory system is one where blood is pumped into open spaces called sinuses, bathing the organs directly. This system is found in arthropods like Anopheles and Limulus, as well as in molluscs such as Limax. In contrast, annelids like Pheretima and Nereis typically possess a closed circulatory system where blood remains confined within vessels, making them distinct from arthropods.

19. (1) A is true but R is false.
All vertebrates are chordates because they possess a notochord during their embryonic stage, which is later replaced by a vertebral column. However, the reasoning that all chordates are vertebrates is incorrect. Other subphyla, like Urochordata and Cephalochordata, are chordates but lack a vertebral column. Therefore, it is accurate to say all vertebrates are chordates, but not all chordates are vertebrates.

20. (2) A only
Annelids possess a true coelom, which is a body cavity completely lined by mesoderm. In contrast, poriferans lack a coelom entirely, being at a cellular level of organization. Aschelminthes are pseudocoelomates because their body cavity is not fully lined by mesoderm. Platyhelminthes are acoelomates, as they lack any body cavity between the gut and the outer body wall.

21. (2) A-III, B-I, C-II, D-IV
Scientific names are often associated with descriptive common names for various fish species. Pterophyllum is commonly known as the angel fish, while Myxine is referred to as the hag fish. Pristis is distinguished as the saw fish due to its rostrum. Exocoetus is famously known as the flying fish. These common names reflect unique morphological features or behaviors characteristic of each genus.

22. (3) A-II, B-IV, C-I, D-III
Different phyla possess unique anatomical features used for identification. Pleurobrachia belongs to Ctenophora and possesses comb plates

for locomotion. The radula is a rasping organ found in many molluscs. The stomochord is a characteristic structure in Hemichordata. An air bladder is an organ found in Osteichthyes that helps maintain buoyancy. These specific traits are essential for the taxonomic classification of diverse animal groups.

23. (3) B, D and E only
Non-chordates are distinguished from chordates by several key morphological features. They lack a notochord throughout their lives. Their central nervous system is ventral, solid, and double, unlike the dorsal hollow cord of chordates. If a heart is present, it is positioned dorsally. Furthermore, non-chordates do not possess pharyngeal gill slits, and they typically lack a post-anal tail, which are chordate hallmarks.

24. (4) Hemichordata
Radial symmetry is characteristic of adult coelenterates, ctenophores, and echinoderms. In contrast, hemichordates exhibit bilateral symmetry throughout their life cycle. Although echinoderms have bilaterally symmetrical larvae, they transition to radial symmetry as adults. Hemichordates, being worm-like marine animals, maintain a body plan that is strictly bilateral, featuring a proboscis, collar, and trunk, reflecting their evolutionary position closer to the chordates.

25. (2) (B), (C) and (D) only
Ctenophores are exclusively marine, bioluminescent, and diploblastic organisms that reproduce only sexually with external fertilization. Tapeworms, belonging to Platyhelminthes, are hermaphroditic with internal fertilization. While Platyhelminthes are triploblastic and bilaterally symmetrical, they are acoelomate, not pseudocoelomate. Sponges typically exhibit internal fertilization and indirect development, contrary to the suggestion of external fertilization and direct development.

26. (4) (A)-(II), (B)-(I), (C)-(III), (D)-(IV)
Various organisms utilize specialized structures for essential physiological functions. Amoeba uses a contractile vacuole for osmoregulation. Asterias, an echinoderm, relies on a water vascular system for locomotion and feeding. Spongilla, a freshwater sponge, possesses a canal system to facilitate water flow. Taenia, a flatworm, uses flame cells for excretion and osmoregulation. These specialized features are key identifiers for their respective taxonomic groups.

27. (4) hairs, pinna and mammary glands.
Mammals are distinguished by several unique morphological features. The presence of mammary glands, which produce milk to nourish the young, is the most defining characteristic. Additionally, they possess hair on their skin and external ears called pinnae. While other vertebrates may share features like a tympanic membrane or internal development, the combination of hair, pinna, and mammary glands is exclusively mammalian.

28. (4) B and C only
Chordates are fundamentally characterized by the presence of a notochord, a dorsal hollow nerve cord, and paired pharyngeal gill slits at some stage of development. They possess a closed circulatory system and a ventral heart. Unlike pseudocoelomates, chordates are true coelomates and triploblastic. The nervous system in chordates is dorsal, single, and hollow, which distinguishes them from non-chordate groups having ventral cords.

29. (3) chitin
The exoskeleton of arthropods is a tough, protective outer layer composed primarily of chitin. Chitin is a complex polysaccharide that provides structural support and protection against predators and dehydration. This nitrogen-containing carbohydrate is a hallmark of the phylum Arthropoda, allowing these animals to thrive in diverse environments. While other substances like cutin and cellulose are found in plants, chitin is animal-derived.

30. (4) Pavo, Psittacula, Corvus
The digestive tract of birds, including Pavo, Psittacula, and Corvus, features specialized chambers known as the crop and gizzard. The crop serves as a storage area for food, while the muscular gizzard is responsible for grinding food particles, often with the help of swallowed stones. This adaptation compensates for the lack of teeth in birds, facilitating efficient digestion of various materials.

31. (1) Both (A) and (R) are correct and (R) is the correct explanation of (A)
All vertebrates are classified as chordates because they possess a notochord during their embryonic development. However, in the adult

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stage of vertebrates, this notochord is replaced by a cartilaginous or bony vertebral column. This transition is why not all chordates, such as protochordates, are vertebrates. Thus, the replacement of the notochord by the vertebral column explains why vertebrates form a subset of chordates.

32. (4) (ii) (iii) (iv) (i)
Common names and specific characteristics help identify various invertebrates. Physalia is widely known as the Portuguese man of war due to its appearance. Limulus, the king crab, is referred to as a living fossil because it has remained relatively unchanged for millions of years. Ancylostoma is the scientific name for the hookworm, while Pinctada is the genus for the pearl oyster.

33. (2) Neophron
Neophron, being a bird, possesses hollow and pneumatic long bones. These specialized bones contain air cavities, which significantly reduce body weight and aid in flight. This anatomical adaptation is a characteristic feature of the class Aves. In contrast, mammals like Ornithorhynchus and Macropus, as well as reptiles like Hemidactylus, have solid bones without these internal air sacs, reflecting their terrestrial or aquatic lifestyles.

34. (1) (B), (C) and (E) are correct
Echinoderms are triploblastic, coelomate animals, and possess a unique water vascular system. Roundworms, or Aschelminthes, exhibit an organ-system level of body organization. Metagenesis, the alternation of generations, is seen in cnidarians like Obelia, not helminths. Comb plates are characteristic of ctenophores and are used for locomotion, not digestion. Thus, the statements regarding echinoderms and roundworms correctly describe their biological features.

35. (4) (iii) (iv) (ii) (i)
Specific morphological features define different phyla. Metamerism, or true segmentation, is a key characteristic of Annelida. A canal system is found in Porifera to facilitate water movement. Ctenophora are identified by the presence of eight rows of ciliated comb plates used for locomotion. Cnidoblasts, or stinging cells, are the defining feature of Coelenterata, used for defense and capturing prey. These traits are essential for taxonomic identification.

36. (2) platyhelminthes
Platyhelminthes, commonly known as flatworms, are characterized by bilateral symmetry and an acoelomate body plan. This means they possess three germ layers but lack a fluid-filled body cavity between the gut and the body wall. Ctenophores exhibit radial symmetry, while aschelminthes are pseudocoelomates. Annelids are true coelomates with segmented bodies. Therefore, the combination of bilateral symmetry and lack of a coelom is specific to platyhelminthes.

37. (1) (ii) (iii) (iv) (i)
Fishes and related vertebrates exhibit various distinguishing characteristics. Cyclostomes typically possess 6 to 15 pairs of gill slits for respiration. Chondrichthyes, the cartilaginous fishes, are characterized by a heterocercal caudal fin. Osteichthyes, or bony fishes, have an air bladder to regulate buoyancy. Trygon, commonly known as the stingray, possesses a poison sting on its tail for defense. These features are key diagnostic traits for each group.

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38. (4) (B) and (C)
In the phylum Chordata, vertebrates are characterized by having a notochord only during the embryonic period. The central nervous system of all chordates is dorsal and hollow. In Urochordata, the notochord is restricted to the larval tail and is not present throughout life. Chordata is divided into three subphyla: Urochordata, Cephalochordata, and Vertebrata, whereas Hemichordata is now considered a separate phylum altogether.

39. (2) (iv) (i) (ii) (iii)
Locusta is recognized as a gregarious and polyphagous pest. Asterias, an echinoderm, displays radial symmetry as an adult but bilateral symmetry during its larval stage. Scorpions are arthropods that breathe through specialized structures called book lungs. Ctenoplana, belonging to the phylum Ctenophora, exhibits the phenomenon of bioluminescence. Matching these organisms with their specific biological traits demonstrates the diverse adaptations found across different invertebrate phyla.

40. (2) Annelida, Arthropoda and Chordata
Organ system level of organization, bilateral symmetry, and true coelom with segmentation are key features shared by Annelida, Arthropoda, and Chordata. While molluscs are coelomates with organ systems and bilateral symmetry, they generally lack true body segmentation, unlike the other three groups. This combination of advanced features represents a significant evolutionary step in the complexity of animal body plans across these specific phyla.

41. (4) Annelids
Annelids are true coelomates, possessing a body cavity entirely lined by mesoderm, and they exhibit bilateral symmetry. While adult echinoderms are true coelomates, they possess radial symmetry, not bilateral. Aschelminthes are pseudocoelomates, meaning their body cavity is only partially lined with mesoderm. Platyhelminthes are acoelomates, lacking a body cavity altogether. Thus, only annelids fit the description of being both bilaterally symmetrical and true coelomates.

42. (3) (iii) (iv) (ii) (i)
Various invertebrates possess unique anatomical structures. Pila, a mollusc, has a rasping organ called a radula for feeding. Bombyx, the silkworm, uses Malpighian tubules for excretion. Pleurobrachia, a ctenophore, is characterized by eight rows of ciliated comb plates for locomotion. Taenia, a flatworm, utilizes specialized flame cells for osmoregulation and excretion. These specific traits are essential for the biological classification of these organisms.

43. (2) (1)-(iii), (2)-(iv), (3)-(i), (4)-(ii)
Animal genera are classified into phyla based on specific morphological traits. Ophiura, the brittle star, belongs to Echinodermata. Physalia, the Portuguese man of war, is a member of Coelenterata. Pinctada, the pearl oyster, is classified under Mollusca. Planaria is a free-living flatworm belonging to the phylum Platyhelminthes. Correctly identifying these relationships is fundamental to understanding the taxonomic organization of the animal kingdom and its diversity.

44. (1) Earthworm
Metamorphosis is a process involving distinct larval stages before reaching adulthood. Earthworms undergo direct development, meaning the young that hatch from eggs resemble miniature adults without any intervening larval phase. In contrast, tunicates, moths, and starfish all undergo indirect development involving complex larval stages like the tadpole larva in tunicates, caterpillars in moths, and various swimming larvae in starfish.

45. (3) Aves
The class Aves, which includes all birds, is characterized by a digestive system containing a crop and a gizzard. The crop serves to store and soften food, while the muscular gizzard grinds it down, often with the help of small stones. This adaptation is essential for birds because they lack teeth. Other vertebrate groups like amphibians, reptiles, and bony fishes do not possess this specific combination of chambers.

46. (2) Chelone
Homeotherms are animals capable of maintaining a constant body temperature regardless of environmental changes. This group includes all birds and mammals, such as Macropus, Camelus, and Psittacula. Chelone, commonly known as the turtle, belongs to the class Reptilia. Reptiles are poikilotherms, meaning their body temperature fluctuates with the environment. Therefore, they cannot maintain internal thermal stability like homeothermic birds and mammals do.

47. (2) pharynx with gill slits
Hemichordates share the presence of pharyngeal gill slits with chordates, which is a significant characteristic used for respiration. Although hemichordates were previously classified under chordates, they are now a separate phylum because they lack a true notochord, possessing a stomochord instead. Their nervous system is also different, typically having a ventral nerve cord in contrast to the dorsal hollow nerve cord found in all chordates.

48. (2) Whales, Dolphins, Seals
Whales, dolphins, and seals are all examples of aquatic mammals. They are warm-blooded, breathe air through lungs, and nourish their young with milk from mammary glands. Trygon and sharks are cartilaginous fishes, not mammals. Identifying these species correctly requires distinguishing between mammalian traits and the characteristics of other aquatic vertebrates like fishes, which possess different

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respiratory and reproductive systems suitable for life in water.

49. (1) Perissodactyla
The order of the horse is Perissodactyla, which comprises odd-toed ungulates. This taxonomic group also includes rhinoceroses and tapirs. Equidae is the family to which horses belong, while Caballus and Ferus are specific species or subspecies identifiers. Taxonomy categorizes organisms into a hierarchy, and for horses, the order level is specifically defined by their unique hoof structure and limb anatomy characteristic of perissodactyls.

50. (2) choanocytes
In poriferans, the central cavity known as the spongocoel is lined with specialized flagellated cells called choanocytes, or collar cells. These cells play a crucial role in maintaining water flow through the canal system, capturing food particles, and facilitating intracellular digestion. Ostia are the intake pores on the body wall, while the osculum is the large exit opening. Mesenchymal cells are found within the gelatinous matrix of the sponge.

51. (2) All cyclostomes do not possess jaws and paired fins.
Cyclostomes are primitive, jawless vertebrates characterized by a circular suctorial mouth and the absence of paired fins. While most mammals are viviparous, the platypus is a notable egg-laying exception. Reptiles generally have a three-chambered heart, but crocodiles possess a four-chambered one. Not all pisces have an operculum; cartilaginous fishes like sharks have exposed gill slits, unlike bony fishes where gills are covered by an operculum.

52. (1) Viviparity
Viviparity, the process of giving birth to live young, is a characteristic of most mammals, but birds are strictly oviparous, meaning they lay eggs. Both groups are homeothermic, or warm-blooded, and possess an ossified endoskeleton. They also share the primary respiratory mechanism of breathing through lungs. Thus, while they have many similarities in their physiology and skeleton, their reproductive strategy regarding egg-laying versus live birth differs significantly.

53. (3) Cartilaginous endoskeleton : Chondrichthyes
Chondrichthyes, the class of cartilaginous fishes like sharks and rays, consistently possess an endoskeleton made entirely of cartilage. This is an absolute characteristic for the group. In contrast, not all chordates possess jaws, as exemplified by jawless cyclostomes. Most reptiles have a three-chambered heart, but crocodiles have four. While many mammals are viviparous, monotremes like the platypus are oviparous, meaning they lay eggs instead of giving birth.

54. (1) Parapodia
Parapodia are lateral, fleshy appendages found in certain annelids, such as Nereis, and are used for locomotion and respiration. These structures are completely absent in the phylum Arthropoda. Arthropods are instead characterized by jointed appendages, a chitinous exoskeleton, and metameric segmentation. These features define the group and facilitate their survival in various habitats, whereas parapodia remain a unique evolutionary development within the annelid lineage.

55. (4) Porifera.
The phylum Porifera is characterized by a cellular level of organization where cells form a meshwork without true tissues. Their internal cavities, including the canal system and spongocoel, are lined with specialized flagellated cells called choanocytes that filter food from the water. Development in sponges is indirect, involving a larval stage. These features are unique to sponges and distinguish them from more complex phyla like molluscs or coelenterates.

56. (4) alternation of generation between asexual and sexual phases of an organism.
Metagenesis is a biological phenomenon where an organism alternates between a sexual and an asexual phase within its life cycle. This is famously observed in cnidarians like Obelia, where the sessile polyp stage reproduces asexually to form medusae, and the free-swimming medusa stage reproduces sexually to form polyps. It is distinct from metamorphosis, which describes physical changes during development, or polymorphism, which refers to different structural forms.

57. (2) Petromyzon
Petromyzon, commonly known as the lamprey, is a jawless fish belonging to the class Cyclostomata. It exhibits an anadromous life cycle, where adults

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live in the ocean but migrate to fresh water to spawn. After spawning, the adults die, and the ammocoetes larvae develop in fresh water for several years. Following metamorphosis, these larvae transform into adults and return to the ocean to complete their life cycle.

58. (1) Trichinella spiralis
Trichinella spiralis is an endoparasitic nematode that exhibits viviparity, meaning the female releases live larvae instead of laying eggs. These larvae then migrate through the host's body and encyst in muscular tissue. Other common nematodes like Ascaris lumbricoides, Ancylostoma duodenale, and Enterobius vermicularis are oviparous, laying eggs that are typically passed out of the host's body to continue their development in the environment.

59. (4) Characteristics: Mouth ventral; gills without operculum; skin with placoid scales; persistent notochord. Class: Chondrichthyes
Chondrichthyes are cartilaginous fishes characterized by a ventral mouth, gills lacking an operculum, placoid scales, and a persistent notochord throughout life. While other classes have defining features, they often have exceptions. For instance, not all mammals have pinnae or are viviparous, and not all cyclostomes have paired appendages. The combination of features for Chondrichthyes is consistently observed across the class without the major exceptions found in other vertebrate groups.

60. (1) Platypus
The platypus is a unique mammal that belongs to the group of monotremes, which are characterized by laying eggs rather than giving birth to live young. This makes it oviparous. In contrast, most other mammals, including whales, bats, and elephants, are viviparous, meaning they develop their young internally and give birth to them. Despite being oviparous, the platypus still possesses other mammalian traits like mammary glands and hair.

61. (1) Exoskeleton
The diversification of insects on land is primarily attributed to their tough, chitinous exoskeleton. This structure provides essential protection against physical damage and predators. More importantly, it acts as a waterproof barrier that minimizes water loss, allowing insects to survive in various terrestrial environments where dehydration is a constant threat. While features like eyes and segmentation are important, the exoskeleton was the key adaptation for land colonization.

62. (4) Cnidaria
The phylum Cnidaria includes a wide variety of species that inhabit both marine and freshwater environments. For example, jellyfish and corals are predominantly marine, while Hydra is a well-known freshwater genus. In contrast, echinoderms, ctenophores, and cephalochordates are exclusively marine organisms. The ability of cnidarians to adapt to different salinities has contributed to their broad distribution and success across diverse aquatic ecosystems globally.

63. (2) regeneration
Planaria, a genus of free-living flatworms, is famous for its extraordinary capacity for regeneration. If an individual is cut into several pieces, each fragment has the potential to regrow into a complete, functional organism. This ability is due to a large population of stem cells called neoblasts. While some other animals show limited regenerative powers, the level of whole-body regeneration exhibited by Planaria is among the highest in the animal kingdom.

64. (2) Torpedo
Torpedo is a genus of marine cartilaginous fish, commonly known as electric rays, which possess specialized organs capable of producing electric currents. These electric organs, derived from modified muscle tissue, are used for both defense and stunning prey. Other cartilaginous fishes like Pristis, Trygon, and Scoliodon do not have this capability, although they possess other specialized structures like the saw-like rostrum or venomous tail stings for their survival.

65. (1) House fly, butterfly, tse-tse fly, silver fish - Insecta
The group consisting of house flies, butterflies, tse-tse flies, and silver fish is correctly classified under the class Insecta. All these organisms share common insectan characteristics, such as having three pairs of jointed legs and a body divided into head, thorax, and abdomen. Other listed groups contain misclassifications; for example, cuttle fish is a mollusc and sea urchins are echinoderms, not fishes or insects, reflecting different taxonomic lineages.

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66. (1) Prawn, Scorpion, Locusta
Prawns, scorpions, and Locusta all belong to the phylum Arthropoda. They share fundamental characteristics such as a chitinous exoskeleton, jointed appendages, and a segmented body plan. In other options, animals like sponges and starfish or earthworms and tapeworms belong to entirely different phyla, such as Porifera, Echinodermata, Annelida, and Platyhelminthes. Grouping animals by phylum requires identifying these shared ancestral and structural traits common to all members.

67. (3) Petromyzon - Ectoparasite - Cyclostomata
Petromyzon, also known as the lamprey, is correctly identified as an ectoparasite belonging to the class Cyclostomata. It attaches to fish to feed. Other matches are incorrect: Limulus belongs to Arthropoda, not Pisces. Adamsia is a cnidarian, not a member of Porifera. Ichthyophis is a limbless amphibian, not a reptile. These corrections emphasize the importance of matching specific biological traits and accurate taxonomic classifications for various animal species.

68. (4) silver fish.
Silver fish is a common name for a small, wingless insect, making it a representative of the phylum Arthropoda. Despite its name, it is not a fish. Puffer fish, flying fish, and cuttle fish belong to different groups; the first two are true bony fishes in the class Osteichthyes, while the cuttle fish is a mollusc. Distinguishing between common names and scientific classifications is essential in identifying the correct phylum for organisms.

69. (4) body covered with dry and cornified skin, scales over the body are epidermal, they do not have external ears.
Class Reptilia is characterized by organisms with dry, cornified skin and epidermal scales or scutes. They lack external ear openings, with the tympanum representing the ear. Their limbs, when present, usually have five digits. Unlike amphibians, they do not have moist skin, and unlike fishes, they are primarily terrestrial and breathe through lungs. These features represent evolutionary adaptations for a life spent mostly on land, independent of aquatic environments.

70. (4) Ctenophora
Ctenophores, commonly known as comb jellies, are a phylum of marine animals that reproduce exclusively through sexual means. They are generally hermaphroditic, producing both eggs and sperm. In contrast, other groups like Cnidaria, Porifera, and Protozoa can reproduce through both sexual and asexual methods, such as budding, fragmentation, or fission. The reliance on purely sexual reproduction is a distinguishing biological feature of the ctenophore phylum.

71. (4) Duckbilled platypus - Oviparous - Mammalia
The duckbilled platypus is correctly identified as an oviparous member of the class Mammalia. While it possesses mammalian traits like hair and mammary glands, it lays eggs instead of giving birth to live young. Other options are incorrect: millipedes are in Myriapoda, not Arachnida; sea anemones are diploblastic, not triploblastic; and silver fish is an arthropod, not a chordate, and lacks fins entirely.

72. (4) their pectoral fins distinctly marked off from cylindrical bodies.
Sharks and dogfishes have cylindrical bodies with pectoral fins that are clearly distinct and marked off. In contrast, skates and rays have flattened bodies where the pectoral fins are fused with the head and trunk, creating a wing-like appearance. Furthermore, sharks have lateral gill slits, while skates and rays have ventral ones. This structural difference in body shape and fin attachment is a primary way to distinguish these groups of cartilaginous fishes.

73. (2) (iv) (i) (ii) (iii)
Pila is a mollusc that possesses a rasping organ called a radula, but its body is unsegmented. Segmentation is characteristic of annelids and arthropods, not typically found in molluscs like Pila. The other matches are correct: Asterias is a spiny-skinned echinoderm with a water vascular system; Sycon is a pore-bearing sponge with a canal system; and Periplaneta is an arthropod with jointed appendages and a chitinous exoskeleton.

74. (4) Sea horse and flying fish - Cold blooded (poikilothermal)
Both the sea horse and the flying fish are members of the class Osteichthyes, which are cold-blooded or poikilothermic animals. This means their body temperature varies with the environment. In the

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other pairs, Ornithorhynchus is oviparous while Pteropus is viviparous; crocodiles have a four-chambered heart while garden lizards have three; and Ascaris and Ancylostoma are nematodes that lack the metameric segmentation found in annelids.

75. (2) All bony fishes have four pairs of gills and an operculum on each side.
Bony fishes, or Osteichthyes, are consistently characterized by having four pairs of gills covered by an operculum. Other groups have exceptions: not all reptiles have a three-chambered heart as crocodiles have four; some sponges live in freshwater like Spongilla; and not all mammals are viviparous, with the platypus being a well-known egg-laying exception. Therefore, the description of bony fishes is the only one provided that holds true without exception.

76. (4) Male shark-claspers borne on pelvic fins
In sharks, males can be distinguished from females by the presence of claspers, which are specialized structures located on the pelvic fins used for internal fertilization. This is a clear morphological marker of sex. Other options are inaccurate because it is the male Ascaris that has a curved posterior end, male frogs possess copulatory pads on the forelimbs, not hind limbs, and both male and female cockroaches possess anal cerci.

77. (3) Chondrichthyes : possess cartilaginous endoskeleton
The class Chondrichthyes, which includes sharks and rays, is defined by having an endoskeleton made entirely of cartilage throughout life. This trait is consistent across all members. Other groups have exceptions: some reptiles like crocodiles have four-chambered hearts; not all chordates like jawless fishes have jaws; and not all mammals give birth to live young, as monotremes lay eggs. Thus, the cartilaginous skeleton is the only exception-free match provided.

78. (2) Salamandra - (i) A tympanum represents ear, (ii) Fertilization is external - Amphibia
Salamandra is an amphibian that possesses a tympanum as an external representation of the ear and typically undergoes external fertilization in water. Other choices contain errors: Ascaris is a non-segmented nematode belonging to Aschelminthes, not Annelida. Pteropus, the flying fox, is a viviparous mammal, not oviparous. Aurelia, or jellyfish, exhibits a tissue level of organization, not organ level, and is characterized by the presence of specialized stinging cells called cnidoblasts.

79. (3) It is absent throughout life in humans from the very beginning.
In humans, like all chordates, a notochord is present during the early embryonic stage. It is eventually replaced by the vertebral column as development proceeds. The claim that it is absent from the very beginning is incorrect. In contrast, it is true that the notochord is limited to the larval tail in ascidians, replaced by a vertebral column in adult frogs, and persists throughout the entire life of Amphioxus.

80. (4) (C) and (D) have a true coelom.
Animals like Pheretima and Hirudinaria possess a true coelom, which is a fluid-filled body cavity completely lined by mesoderm. This feature is a hallmark of annelids and more complex phyla. Other statements are incorrect because respiration in arthropods usually occurs via specialized organs like tracheae or gills, many complex invertebrates exhibit bilateral rather than radial symmetry, and cnidoblasts are exclusive to the phylum Cnidaria for defense and prey capture.

81. (1) Flatworms
Flatworms, or Platyhelminthes, are triploblastic, meaning they possess three primary germ layers: ectoderm, mesoderm, and endoderm. This development allows for more complex organ structures compared to simpler organisms. Sponges are generally considered to have a cellular level of organization without distinct germ layers. Ctenophores and corals are diploblastic, having only two germ layers, the ectoderm and endoderm, with a non-cellular mesoglea between them.

82. (1) Roundworms (Aschelminthes) are pseudo-coelomates.
Roundworms are correctly classified as pseudocoelomates because their body cavity is not entirely lined with mesoderm; instead, the mesoderm exists as scattered pouches. Other statements are false: molluscs are true coelomates, insects are also true coelomates with a reduced cavity called a hemocoel, and flatworms are acoelomates, meaning they lack a body cavity altogether. Understanding these

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cavity types is fundamental for the taxonomic classification of different animal phyla.

83. (4) Fasciola.
Fasciola, also known as the liver fluke, possesses an incomplete digestive system where a single opening serves as both the mouth for ingestion and the anus for egestion. This is typical of many members of the phylum Platyhelminthes. In contrast, more complex animals like Octopus, Asterias, and Ascidia have a complete digestive system with two separate openings, allowing for a one-way flow of food and more efficient nutrient processing.

84. (3) Spongilla has special collared cells called choanocytes, not found in the remaining three.
Spongilla, as a sponge, possesses unique flagellated cells called choanocytes that are essential for water circulation and feeding. These cells are a defining feature of the phylum Porifera and are not present in leeches, dolphins, or penguins. Other options are incorrect because penguins and dolphins are both homoiothermic, leeches and Spongilla are freshwater forms while others are marine, and sponges often show asymmetry rather than bilateral symmetry.

85. (2) Earthworm - Pharyngeal, integumentary and septal nephridia
Earthworms possess three types of nephridia for excretion: pharyngeal, integumentary, and septal. These structures filter waste from the blood and coelomic fluid. Humans use kidneys as primary excretory organs, but sebaceous and tear glands have different functions. Cockroaches primarily use Malpighian tubules, while enteric caeca are digestive organs. Frogs utilize kidneys and skin, but the buccal epithelium is not a primary excretory surface, making the earthworm match the most accurate.

86. (4) Have gill slits at some stage
Crocodiles, penguins, whales, and dogfishes all belong to the phylum Chordata. A fundamental characteristic of all chordates is the presence of pharyngeal gill slits at some stage during their development, typically in the embryonic phase. While dogfishes retain gills as adults, the others lose them. Other features like skeletal composition or reproductive methods vary significantly among these different classes of vertebrates, but the embryonic presence of gill slits is a shared ancestral trait.

87. (1) Aschelminthes (roundworms)
Aschelminthes, or roundworms, are characterized by having bilateral symmetry and being triploblastic, meaning they develop from three germ layers. While they are pseudocoelomates rather than true coelomates, they fit the description of being bilaterally symmetrical and triploblastic. In contrast, ctenophores and coelenterates are diploblastic and generally show radial symmetry, while sponges have a simpler cellular level of organization and often exhibit asymmetry or limited symmetry.

88. (2) Lampreys and hag fishes
Lampreys and hag fishes are the two main groups of living jawless fishes, classified under the superclass Agnatha and class Cyclostomata. They lack true jaws and paired fins, and their skeletons are primarily cartilaginous. Other fishes mentioned, like mackerels, rohu, guppies, and eels, are jawed fishes belonging to the classes Chondrichthyes or Osteichthyes. The absence of jaws is an ancestral vertebrate characteristic that distinguishes agnathans from all other fish groups.

89. (3) Scales on their hind limbs
The presence of epidermal scales on the hind limbs of birds is a significant morphological trait inherited from their reptilian ancestors. While other features like laying calcareous eggs are shared, scales are a direct anatomical link to reptiles. Crop and gizzard are specialized avian digestive adaptations, and a four-chambered heart evolved independently in birds, crocodiles, and mammals. Therefore, scales remain one of the most visible indicators of the evolutionary relationship between birds and reptiles.

90. (4) presence of neither true coelom nor metamerism.
Ascaris, a member of the phylum Aschelminthes, is characterized by a pseudocoelom, which is not a true coelom because it is not fully lined with mesoderm. Additionally, Ascaris lacks metamerism, which is the true serial segmentation found in annelids and arthropods. Its body is smooth and unsegmented. Therefore, it possesses neither a true coelom nor metameric segmentation, which are advanced features found in higher animal phyla like Annelida and Chordata.

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91. (1) Scorpion, spider, cockroach - Ventral solid central nervous system
Scorpions, spiders, and cockroaches are all arthropods, and a defining characteristic of this phylum is a ventral, solid, and double central nervous system. Other options are incorrect: Taenia is not metamerically segmented; sea anemones exhibit radial symmetry while liver flukes are bilateral; and sea urchins, being echinoderms, lack the jointed appendages characteristic of arthropods like prawns and centipedes. This highlights the importance of matching correct morphological traits with their respective animal groups.

92. (2) Mollusca - normally oviparous and development through a trochophore or veliger larva
Molluscs are typically oviparous, meaning they lay eggs, and their indirect development often involves characteristic larval stages like the trochophore or veliger. Other descriptions have errors: echinoderms usually have external fertilization; arthropods are not always divided into three parts (e.g., spiders have a cephalothorax) and some use gills or book lungs; and many chordates have a cloaca rather than separate anal and urinary openings.

93. (1) Pseudocoelom
Annelids are true coelomates, meaning their body cavity is completely lined with mesoderm. A pseudocoelom is a characteristic feature of Aschelminthes, not Annelida. Annelids are also known for their metameric segmentation, a closed circulatory system, and a ventral nerve cord. These features differentiate them from simpler phyla and align them with more complex animal groups. Therefore, the presence of a pseudocoelom is the only listed trait that does not belong to annelids.

94. (4) (i), (iii) and (iv)
Multiple vertebrate and invertebrate groups exhibit specific biological traits. Crocodiles are unique among reptiles for having a four-chambered heart. Obelia, a cnidarian, undergoes metagenesis, an alternation between polyp and medusa stages. Mammals like lemurs possess thecodont dentition, where teeth are embedded in sockets. However, sea urchins lack parapodia, which are locomotor organs found in certain annelids. Thus, matching these specific traits requires accurate knowledge of diverse animal physiology and anatomy.

95. (1) Ventral central nervous system - Leech
Leeches, as annelids, possess a ventral, solid, and double central nervous system, which is a key characteristic of non-chordate invertebrates. In contrast, chordates like Chamaeleon possess pharyngeal gill slits at the embryonic stage, scorpions have a dorsal heart, and Octopuses, being molluscs, do not have a post-anal tail, which is a chordate hallmark. Identifying the correct body feature for a specific animal group involves understanding these fundamental anatomical differences.

96. (4) Homoiothermy
Parrot, platypus, and kangaroo are all homoiothermic, meaning they are warm-blooded and can maintain a constant body temperature regardless of environmental conditions. While parrots are birds and the others are mammals, they share this advanced physiological trait. They do not share toothless jaws (kangaroos have teeth), functional post-anal tails (parrots' are feathers), or ovoparity (kangaroos are viviparous). Homoiothermy is the only unifying characteristic among these three diverse vertebrates.

97. (1) They all possess dorsal heart.
Nereis, scorpions, cockroaches, and silver fish are all non-chordate invertebrates, which are characterized by having a dorsal heart if a circulatory system is present. They do not all belong to the same phylum (Nereis is an annelid, others are arthropods), and they are not all terrestrial (Nereis is aquatic). Furthermore, Nereis lacks the jointed appendages that define the other three arthropod species. The dorsal heart remains their common structural feature.

98. (4) annelida and arthropoda.
Metameric segmentation is the serial repetition of similar body segments along the longitudinal axis of an animal. This is a primary characteristic of the phyla Annelida and Arthropoda. In annelids, it is visible both externally and internally, whereas in arthropods, segments are often fused to form distinct body regions like the head, thorax, and abdomen. This organizational pattern is not a defining feature of molluscs, platyhelminthes, or echinoderms.

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99. (3) Ctenoplana and Beroe
Ctenoplana and Beroe are members of the phylum Ctenophora, which are characterized by biradial symmetry and the lack of cnidoblasts (stinging cells). Instead, they use specialized sticky cells called colloblasts to capture prey. Hydra and sea anemones possess cnidoblasts, and starfish exhibit pentamerous radial symmetry. Therefore, the combination of biradial symmetry and absence of stinging cells is uniquely diagnostic for ctenophores like Ctenoplana and Beroe.

100. (3) jointed legs and chitinous exoskeleton
Centipedes, cockroaches, and crabs are all members of the phylum Arthropoda. They share fundamental traits including jointed appendages (legs) and a protective exoskeleton made of chitin. While they have other features, they differ in respiratory organs (tracheae vs. gills) and excretory structures (Malpighian tubules vs. green glands). Jointed legs and the chitinous exoskeleton are the core unifying characteristics that define their classification within this diverse animal phylum.

101. (1) Kangaroo, hedgehog, dolphin, Loris
Kangaroo, hedgehog, dolphin, and Loris are all viviparous mammals, meaning they give birth to live young. This group includes a marsupial and various placental mammals from diverse habitats. Other sets include oviparous (egg-laying) animals like the platypus, ostrich, penguin, or kiwi, which prevents the entire set from being classified as viviparous. Correct identification of mammalian reproductive strategies is key to distinguishing between those that lay eggs and those that provide internal development.

102. (4) Mollusca - Loligo, Teredo, Octopus
Loligo (squid), Teredo (shipworm), and Octopus are all correctly classified as members of the phylum Mollusca. Other options contain misclassifications: Pennatula is a cnidarian, not a sponge; Bonellia is an annelid, not a cnidarian; and Enterobius is a nematode, not a flatworm. Accurate taxonomic grouping requires matching multiple example organisms with the specific structural and biological features that define their respective phylum.

103. (2) These are all unicellular protists.
Trypanosoma, Noctiluca, Monocystis, and Giardia are all unicellular eukaryotic organisms classified under the kingdom Protista. While some are parasitic, such as Trypanosoma and Giardia, Noctiluca is a free-living marine organism known for bioluminescence. They do not all have flagella (Monocystis is an apicomplexan), and they do not all produce spores in the same way. Their unifying biological characteristic is being single-celled eukaryotes, placing them within the diverse group of protists.

104. (1) absence of body cavity
Platyhelminthes, or flatworms, are acoelomate, meaning they lack a body cavity between the gut and the outer body wall. In contrast, annelids are true coelomates with a fluid-filled body cavity completely lined by mesoderm. Both groups exhibit bilateral symmetry and are triploblastic. The absence of any form of coelom is the primary structural difference that distinguishes flatworms from the more complex, segmented annelids that possess a true coelom.

105. (1) Prawn has two pairs of antennae.
The statement that prawns have two pairs of antennae is factually correct. In crustaceans such as prawns, there are two pairs of antennae (the first pair often called antennules), which is a key trait distinguishing them from insects, which have only one pair, and arachnids, which lack them entirely. This precise anatomical knowledge is essential in invertebrate biology.

106. (3) Ten pairs of cranial nerves
Mammals are characterized by having twelve pairs of cranial nerves, not ten. Other typical mammalian traits include thecodont dentition (teeth in sockets), alveolar lungs for efficient gas exchange, and a consistent seven cervical vertebrae in the neck, which is found in almost all species from shrews to giraffes. The presence of ten pairs of cranial nerves is a characteristic of fishes and amphibians, distinguishing them from the more advanced reptiles, birds, and mammals.

107. (4) Echinodermata.
Echinoderms exhibit a unique developmental transition in their symmetry. The larvae are bilaterally symmetrical, which is their ancestral condition. As they undergo metamorphosis into adults, they develop pentamerous radial symmetry. This characteristic, along with a water vascular system and a calcareous endoskeleton, defines the phylum. Other phyla like Annelida and Mollusca maintain bilateral symmetry

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throughout their life cycles, and cnidarians are primarily radial in all stages.

108. (1) Insecta
In the class Insecta, the body is consistently divided into three distinct regions: the head, thorax, and abdomen. This is a primary diagnostic feature of the group. In contrast, other arthropod classes like Crustacea and Arachnida often have the head and thorax fused into a single unit called a cephalothorax. Insects also uniquely possess three pairs of legs attached to the thorax, further distinguishing them from other many-legged or eight-legged arthropods.

109. (4) frogs evolved from gilled ancestors.
The presence of gills in frog tadpoles is a classic example of ontogeny recapitulating phylogeny. Since tadpoles are aquatic and use gills for respiration, it indicates that modern amphibians evolved from ancestors that were entirely aquatic and breathed through gills, such as ancient fishes. This developmental stage reflects their evolutionary history before they transitioned to a semi-terrestrial lifestyle using lungs and skin as adults.

110. (2) presence of diaphragm
The presence of a muscular diaphragm that separates the thoracic and abdominal cavities is a unique and defining feature of the mammalian body. This muscle is essential for the efficient breathing mechanism characteristic of mammals. While homeothermy and four-chambered hearts are found in birds as well, and rib cages are common to many vertebrates, the diaphragm is an anatomical hallmark specifically restricted to the class Mammalia.

111. (2) multicellular without any tissue organization
Sycon, a member of the phylum Porifera, is a multicellular organism that exhibits a cellular level of organization. This means that while it consists of many specialized cells, these cells are not organized into true tissues or organs. Sponges like Sycon rely on a canal system for circulating water to facilitate feeding and respiration. This lack of tissue layers distinguishes them from more complex multicellular animals like coelenterates or flatworms.

112. (4) miracidium and metacercaria.
The life cycle of Fasciola hepatica involves several larval stages. The miracidium is the stage that infects the intermediate host, which is usually a snail. After developing through several other stages inside the snail, the parasite emerges and eventually becomes a metacercaria. This metacercarial stage is what infects the primary host, such as sheep or humans, typically when they ingest contaminated vegetation, completing the complex parasitic cycle.

113. (1) cockroach
Ommatidia are the individual visual units that make up the compound eyes of many arthropods, including cockroaches. Each ommatidium functions as a separate light-sensitive receptor, allowing the insect to perceive a mosaic-like image of its surroundings. This type of vision is highly effective for detecting movement. Mammals and frogs possess simple eyes with a single lens, which function differently than the complex compound eyes found in insects.

114. (2) Musca - Complete metamorphosis
Musca, the common housefly, undergoes complete metamorphosis, which includes four distinct stages: egg, larva (maggot), pupa, and adult. This developmental process allows the different stages to occupy various niches. Other options are incorrect because Pheretima (earthworm) is hermaphroditic and lacks sexual dimorphism; Chameleon shows color change for camouflage rather than mimicry; and Taenia (tapeworm) is characterized by a segmented body rather than polymorphism, which is seen in cnidarians.

115. (2) (A), (B) and (C)
Various animals utilize different respiratory organs. Silver fish use tracheae, scorpions possess book lungs, and sea squirts rely on pharyngeal slits for gas exchange. Dolphins, being mammals, breathe through lungs rather than their skin. Identifying correct matches requires understanding the diverse physiological adaptations for respiration across different animal groups, from primitive invertebrates like arthropods and tunicates to more complex aquatic mammals like dolphins.

116. (4) Hydra
Hydra possesses a simple nervous system consisting of a network of nerve cells, known as a nerve net, but it lacks a centralized brain. This primitive arrangement allows the organism to respond to stimuli from any direction. In contrast, sponges lack nerve cells entirely,

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while earthworms and cockroaches have more developed nervous systems with localized ganglia that function as rudimentary brains. Thus, Hydra represents an early stage in the evolution of neural organization.

117. (1) All chordates
A defining characteristic of the phylum Chordata is the presence of a notochord at some stage during their life cycle. For many chordates, especially vertebrates, the notochord is prominent during the embryonic stage and is later replaced by a vertebral column in adults. However, in some groups like cephalochordates, it persists throughout life. Regardless of its fate in adulthood, the notochord is an essential embryonic feature shared by all members of this phylum.

118. (4) Mollusca
Haemocyanin is a blue, copper-containing respiratory pigment found in the blood of various molluscs and some arthropods. It functions similarly to hemoglobin by transporting oxygen to tissues. While annelids and vertebrates often use iron-based hemoglobin, many molluscs like octopuses and snails rely on haemocyanin. This pigment turns blue when oxygenated and colorless when deoxygenated, reflecting a different evolutionary solution for gas transport in these animal groups.

119. (4) Snake
Snakes, being chordates, possess a post-anal tail, which is a fundamental characteristic of the phylum. This structure extends beyond the anus and is supported by skeletal elements. In contrast, invertebrates like earthworms and scorpions do not have a post-anal tail, as their body typically ends at the anus. The presence of this tail at some stage of development is one of the key features that distinguish chordates from all other animal groups.

120. (3) mouth and body wall
In Hydra, the mouth serves both for ingestion and for the egestion of undigested food particles, as they possess an incomplete digestive system. Nitrogenous waste products, primarily ammonia, are removed through the process of simple diffusion across the general body wall into the surrounding water. This reflects a simple physiological organization where specialized excretory organs are absent, and life processes are handled by basic cell surfaces.

121. (2) Hydra
Hydra exhibits a cell-tissue grade of organization, where specialized cells are coordinated to perform specific functions as tissues, such as the nerve net and muscle layers. This is more advanced than the cellular level found in sponges. However, it lacks the organ or organ-system level of organization seen in organisms like liver flukes and Ascaris. The scattered arrangement of cells within its two germ layers characterizes this transitional level of biological complexity in cnidarians.

122. (1) holoblastic equal
Cleavage in most mammals is holoblastic and equal, meaning the entire zygote divides completely into blastomeres of roughly the same size. This occurs because mammalian eggs have very little yolk (alecithal), allowing for an even distribution of the cytoplasm during early divisions. This pattern of early embryonic development is essential for forming the blastocyst, which will eventually implant into the uterine wall for further growth and development.

123. (1) sexual dimorphism
Both Ascaris lumbricoides and Anopheles stephensi exhibit sexual dimorphism, where males and females are clearly distinguishable by their external morphology. In Ascaris, the male is smaller and has a curved tail, while the female is larger and straight. In Anopheles, differences are seen in mouthparts and antennae. Other traits like metamerism or anaerobic respiration do not apply to both species, as one is a nematode and the other an insect.

124. (1) Diaphragm
The diaphragm is a muscular partition unique to mammals and is not found in other chordate classes like fishes, amphibians, reptiles, or birds. In contrast, all chordates share three fundamental features at some stage of their life cycle: a notochord, a dorsal hollow nerve cord, and pharyngeal gill clefts. Therefore, while these three traits are universal chordate hallmarks, the diaphragm is a specialized adaptation restricted solely to the class Mammalia.

125. (1) Platypus is oviparous.
The platypus is a unique mammal classified as a monotreme, which means it is oviparous and

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lays eggs rather than giving birth to live young. This is a rare trait within the class Mammalia. Other statements are incorrect: bats possess fur rather than feathers, elephants are viviparous, and all mammals possess a diaphragm. The platypus serves as an evolutionary link, showing both mammalian features and ancestral reptilian reproductive characteristics.

126. (2) ureotelic in water
Many aquatic reptiles are ureotelic when they are in water, meaning they primarily excrete nitrogenous waste in the form of urea. This is a water-conserving strategy compared to ammonotelism. On land, some reptiles may switch to uricotelism to further conserve water by excreting uric acid. These physiological adaptations allow reptiles to maintain their osmotic balance while living in environments with varying water availability, reflecting their evolutionary flexibility.

127. (1) poikilothermic
Poikilothermic animals, commonly known as cold-blooded, are unable to regulate their internal body temperature. Consequently, their internal temperature fluctuates according to the changes in the surrounding environment. This group includes most invertebrates, fishes, amphibians, and reptiles. In contrast, homoiothermic animals like birds and mammals maintain a constant body temperature. Poikilotherms often rely on behavioral adaptations, such as basking in the sun or seeking shade, to manage their thermal levels.

128. (2) sponges
The canal system is the defining physiological feature of sponges, belonging to the phylum Porifera. This system consists of a network of pores, canals, and cavities through which water circulates, driven by flagellated choanocytes. It is vital for providing nutrients, facilitating gas exchange, and removing waste products. While other animals have various circulatory or vascular systems, the specific arrangement of the canal system is unique and essential to sponge biology.

129. (4) Forelimb
In all birds, the forelimbs are highly modified into wings for flight. Therefore, they do not possess typical vertebrate forelimbs used for walking or grasping. Birds still retain a pelvic girdle, pectoral girdle, and hindlimbs, the latter of which are used for perching, walking, or swimming. This specialization of the forelimb is a fundamental avian adaptation that distinguishes them from other tetrapods while enabling their unique aerial lifestyle.

130. (3) aves
The class Aves is characterized by the presence of pneumatic bones, which are long bones that are hollow and contain air passages. This anatomical adaptation significantly reduces body weight, which is essential for flight. These air-filled bones are connected to the respiratory system, further aiding in buoyancy and gas exchange during high-energy aerial activity. This unique skeletal feature distinguishes birds from other terrestrial vertebrates like reptiles and mammals.

131. (2) platyhelminthes
Solenocytes, also known as flame cells, are specialized excretory and osmoregulatory structures primarily found in the phylum Platyhelminthes. These cells contain a cluster of cilia that flicker like a flame, creating a current that draws waste fluid into excretory canals. While other phyla have their own specialized structures like nephridia in annelids or Malpighian tubules in insects, solenocytes remain a hallmark of the flatworm's primitive but effective excretory system.

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132. (3) metagenesis
Metagenesis is the most appropriate term to describe the life cycle of Obelia, a colonial cnidarian. This process involves an alternation of generations between a sessile, asexual polyp stage and a free-swimming, sexual medusa stage. The polyps produce medusae by budding, and the medusae produce gametes that fuse to form new polyps. This is a distinct biological phenomenon from simple metamorphosis or neoteny, characterizing the complex reproductive strategy of certain cnidarians.

133. (1) dentary
In mammals, the lower jaw consists of a single bone known as the dentary. This is a key evolutionary characteristic that distinguishes mammals from other vertebrates, whose lower jaws are composed of several different bones. The transition to a single-boned jaw allowed for stronger biting forces and led to the modification of former jaw bones into the middle ear ossicles.

While the term mandible is often used, the specific bone is the dentary.

134. (3) Leydig's cell
Leydig's cells, also known as interstitial cells, are located between the seminiferous tubules in the testes of mammals like rabbits. Their primary function is to secrete male sex hormones, such as testosterone, in response to stimulation by luteinizing hormone. These hormones are essential for the development of male secondary sexual characteristics and the regulation of spermatogenesis. Sertoli cells, in contrast, provide nutritional support to developing sperm cells but do not secrete these hormones.

135. (1) Jointed legs
Silverfish, scorpions, crabs, and honey bees all belong to the phylum Arthropoda, and their primary unifying characteristic is the possession of jointed legs. This feature enables a wide range of movements and specialized functions across different environments. While many arthropods share other traits like compound eyes or metamorphosis, not all do; for example, silverfish do not undergo metamorphosis, and some lack poison glands. Jointed legs remain the fundamental diagnostic trait for all arthropods.

136. (2) an egg with a juvenile
The embryonated egg of Ascaris contains a fully developed juvenile larva, specifically the second-stage rhabditiform larva. This is the infective stage of the parasite. When a host ingests these embryonated eggs, the juvenile larva hatches in the small intestine to continue its complex migration through the host's body. The egg shell provides crucial protection against environmental stresses, ensuring the survival of the juvenile until it can find a suitable host.

137. (3) mesoderm and body wall (endoderm)
A true coelom is a body cavity that is completely lined by mesoderm. Specifically, it is located between the outer body wall and the inner alimentary canal. This arrangement allows for the independent movement and growth of internal organs. Animals with this feature are called coelomates. If the cavity is only partially lined by mesoderm, it is termed a pseudocoelom, and if no cavity exists, the animal is an acoelomate, like flatworms.

138. (2) They have high regenerative power.
A universal characteristic of all sponges, without exception, is their extraordinary power of regeneration. Even if a sponge is broken into tiny fragments or individual cells, these parts can reorganize and regrow into a complete new organism. Other traits have exceptions: some sponges have siliceous or spongin fibers rather than calcareous spicules; while most are marine, freshwater sponges exist; and sponges can be asymmetrical or exhibit radial symmetry, rather than being strictly radial.

139. (3) pigeon
Pneumatic bones are characteristic of birds like the pigeon. These bones are hollow and filled with air sacs, which is a vital adaptation for flight as it significantly reduces the overall body weight. In contrast, sharks have cartilaginous skeletons, while frogs and whales possess solid, marrow-filled bones. The evolution of pneumatic bones in birds is a specialized skeletal development that supports their unique aerial lifestyle and efficient respiratory system.

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140. (2) flame cells of Planaria
Nephridia in earthworms and flame cells in Planaria are analogous structures because they both perform the primary function of excretion and osmoregulation. While their anatomical details differ, they are both specialized systems for filtering metabolic wastes from the body. Other comparisons, such as with gills for respiration or trachea for gas exchange, involve different physiological functions. Thus, they represent similar evolutionary solutions for maintaining internal chemical balance in different invertebrate phyla.

141. (2) They have seven cervical vertebrae.
A remarkable and nearly universal characteristic among mammals is the presence of seven cervical (neck) vertebrae. This holds true for a wide variety of species, ranging from short-necked rats to long-necked giraffes. Other listed traits are not universal; many mammals undergo some form of hair shedding or skin replacement, dietary habits vary from herbivores to carnivores, and all chordates, including mammals, possess a dorsal rather than a ventral nerve cord.

142. (4) porous walls.
The formation of the canal system in sponges is primarily due to their porous body walls.

These walls contain numerous tiny intake pores called ostia, which allow water to enter the internal chambers and spongocoel. This flow is maintained by the beating of flagellated cells and is essential for nutrition, respiration, and excretion. While internal folding can increase complexity, the fundamental existence of the system relies on the inherently porous nature of the sponge's body.

143. (4) chordata.
Metamerism, or true serial body segmentation, is a fundamental characteristic found in three major animal phyla: Annelida, Arthropoda, and Chordata. In chordates, metamerism is most clearly seen in the arrangement of muscles (myotomes) and the vertebral column during development. While other groups like cestodes show proglottid formation, it is not considered true metamerism. The presence of these repeated segments is a key organizational feature of the complex body plans in these three phyla.

144. (3) radial symmetry
Organisms that are permanently attached to a substratum, known as sessile animals, often possess radial symmetry. This body plan allows them to interact with their environment, capture prey, and detect stimuli equally from all directions. Examples include many coelenterates like sea anemones and corals. Bilateral symmetry is more common in active, motile animals with a defined head. Radial symmetry is a highly effective adaptation for a stationary or slow-moving existence in aquatic habitats.

145. (4) the presence of well-developed skull.
A common and essential characteristic of all vertebrates, without exception, is the presence of a well-developed skull or cranium that protects the brain. Other traits have exceptions: some vertebrates like snakes lack limbs; the body plan does not always clearly show a neck (e.g., in fishes); and not all have a conspicuous exoskeleton. The presence of a cranium is why vertebrates are also referred to as Craniata, defining their membership in this subphylum.

146. (4) nematocysts.
The occurrence of nematocysts, or stinging cells, is a unique and defining feature exclusive to the phylum Coelenterata (Cnidaria). These specialized organelles are used for defense, anchoring, and capturing prey. While other traits like polymorphism or hermaphroditism occur in various animal groups, nematocysts are never found outside of cnidarians. These stinging cells are concentrated on the tentacles and body wall, representing a highly specialized evolutionary adaptation for their predatory lifestyle.

147. (1) are attached to the substratum
Radial symmetry is most commonly exhibited by animals that are attached to a substratum (sessile) or are slow-moving. This body arrangement allows them to perceive and respond to environmental stimuli from all directions, which is advantageous for sedentary life. Examples include corals, sea anemones, and adult echinoderms. In contrast, active animals typically develop bilateral symmetry, which is associated with cephalization and directed movement, allowing for more efficient navigation and hunting.

148. (2) Schistosoma
Schistosoma, commonly known as the blood fluke, is a representative member of the phylum Platyhelminthes. These flatworms are characterized by a dorsoventrally flattened body and are typically parasitic. Other organisms mentioned belong to different groups: Plasmodium and Trypanosoma are unicellular protozoans, while Wuchereria is a nematode belonging to the phylum Aschelminthes. Identifying Schistosoma as a flatworm requires recognizing its multicellular, triploblastic, and acoelomate nature typical of its phylum.

149. (3) Sea anemone
The sea anemone is a completely non-parasitic, free-living organism belonging to the phylum Cnidaria. It lives attached to rocks or other surfaces in marine environments, capturing prey with its tentacles. In contrast, tapeworms, leeches, and certain types of mosquitoes are parasitic, relying on other organisms for nutrition and survival. Sea anemones maintain an independent existence, representing the diverse ecological roles found within the animal kingdom that do not involve a parasitic lifestyle.

150. (1) starfish
Tube feet are characteristic structures of the starfish and other members of the phylum Echinodermata. Part of the water vascular system, these fluid-filled tubes are used for locomotion, attachment to surfaces, and capturing prey.

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While jellyfishes, crayfishes, and cuttlefishes all have different methods of movement and prey capture, none of them possess the unique water-driven tube feet system that is a fundamental biological hallmark of the echinoderm lineage.

151. (1) Frog's tadpole
The frog's tadpole, being a young stage of a vertebrate, possesses a closed circulatory system where blood remains confined within vessels. In contrast, prawns, cockroaches, and other arthropods like Chelifer have an open circulatory system where blood flows into open sinuses and directly bathes the internal organs. This fundamental difference in vascular organization distinguishes the more complex vertebrate circulatory systems from the simpler open systems typically found in many invertebrate phyla.

152. (3) Flightless birds
Ostrich, penguin, and kiwi are all unified by being flightless birds. While they belong to different orders and live in diverse environments, they share the characteristic of having wings that are reduced or modified and are not used for aerial flight. Ostriches are adapted for running, penguins for swimming, and kiwis for a terrestrial existence. This loss of flight is a significant evolutionary adaptation that has occurred independently in several different lineages of birds.

153. (4) Posterior sucker in Hirudinaria
In Hirudinaria, the common leech, the posterior sucker assists in locomotion by providing a strong attachment to the substratum. This allows the animal to move using a characteristic looping or crawling motion. Other structures listed have different functions: trichocysts in Paramecium are for defense, pedicellariae in starfish are for cleaning and protection, and the clitellum in Pheretima is involved in cocoon formation during reproduction, rather than being primary locomotor organs.

154. (3) Rostellar hooks are absent.
Taenia saginata, commonly known as the beef tapeworm, is distinguished from Taenia solium by the absence of rostellar hooks on its scolex. It has four large suckers but lacks the hooks used for attachment that are present in the pork tapeworm. Its intermediate host is cattle, whereas pigs are the intermediate host for Taenia solium. This morphological difference is a key diagnostic feature used by parasitologists to differentiate between these two common human parasites.

155. (1) Hydra
Hydra possesses a very primitive nervous system consisting of a decentralized network of nerve cells known as a nerve net. However, it does not have organized nerves or a centralized brain. This allows for simple coordinated responses to external stimuli. In contrast, tapeworms, earthworms, and frog tadpoles have more complex nervous systems with identifiable nerves and ganglia. Hydra represents one of the simplest levels of neural organization in the animal kingdom.

156. (2) Hydra and sponges
Budding is a common mode of asexual reproduction in both Hydra and various sponges. In this process, a new individual grows as an outgrowth or bud from the parent organism and eventually detaches to live independently. While some other animals can reproduce asexually, budding is particularly characteristic and well-studied in these two groups. In contrast, animals like starfish typically reproduce via fragmentation or sexual means, and tapeworms primarily rely on proglottid production.

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157. (2) noncollapsible walls
The tracheae of both cockroaches and mammals are similar in that they possess noncollapsible walls. In cockroaches, this is achieved through chitinous rings called taenidia, while in mammals, C-shaped cartilaginous rings provide the structural support. This adaptation ensures that the respiratory passages remain open for continuous air flow, despite changes in pressure or body movement. This shared functional feature is an example of convergent evolution for an efficient respiratory system in both groups.

158. (4) butterfly, frog and mosquito.
Butterflies, frogs, and mosquitoes all have distinct larval stages in their life histories, representing indirect development. Butterflies have caterpillars, frogs have tadpoles, and mosquitoes have wrigglers. In contrast, groups containing earthworms or houseflies do not always share this feature across all members mentioned, or they might have different developmental patterns. The consistent presence

of a specialized larval stage is a key biological characteristic that defines the complex life cycles of these diverse organisms.

159. (4) order.
Gorilla, chimpanzee, monkeys, and humans are all classified within the same taxonomic order, which is Primates. They share common characteristics such as complex social behaviors, forward-facing eyes, and highly developed brains. While they belong to different families, genera, and species, their placement in the same order reflects their shared evolutionary heritage and fundamental biological similarities. Taxonomy uses these hierarchical levels to organize the vast diversity of life based on ancestral relationships.

160. (2) Muscular diaphragm between thorax and abdomen
Whales, bats, and rats are all mammals and share the defining characteristic of having a muscular diaphragm that separates the thoracic and abdominal cavities. This muscle is essential for their respiratory process. Other listed traits are not shared by all three; for example, whales do not have a visible neck or external ears, and the position of testes can vary. The presence of a diaphragm remains a fundamental and unique anatomical hallmark of the entire class Mammalia.

161. (1) Echinoidea
Aristotle's lantern is a complex, five-toothed masticatory apparatus found specifically in members of the class Echinoidea, such as sea urchins. It is used for scraping algae and other food sources from rocky surfaces. This specialized structure is not present in other echinoderm classes like Asteroidea (starfish), Holothuroidea (sea cucumbers), or Ophiuroidea (brittle stars). It represents a unique evolutionary adaptation for feeding within the sea urchin lineage, distinguishing them from their relatives.

162. (1) asteriodea
Starfish are classified under the class Asteroidea within the phylum Echinodermata. This class is characterized by a central disc with radiating arms, typically five in number, which are not sharply marked off from the disc. They possess a water vascular system and move using tube feet. Other echinoderm classes include Ophiuroidea (brittle stars) and Holothuroidea (sea cucumbers), which have different body forms. Asteroidea is the definitive group for common sea stars or starfish.

163. (4) cephalopoda.
Members of the molluscan class Cephalopoda, such as octopuses and squids, possess highly advanced eyes that remarkably resemble the vertebrate eye in structure and function. They have a lens, retina, and iris, capable of forming sharp images. This is an example of convergent evolution, where two different lineages evolved similar complex organs independently. Other molluscan groups like bivalves or gastropods have much simpler light-sensing structures, reflecting the cephalopod's active, predatory lifestyle.

164. (2) sitting posture
Adult Culex and Anopheles mosquitoes can be most easily distinguished by their sitting posture. An Anopheles mosquito typically rests with its body at an angle to the surface, with its head down and abdomen pointed upwards. In contrast, a Culex mosquito sits with its body parallel to the surface. While mouthparts and wings may show subtle differences, the resting angle is the most practical diagnostic feature used by entomologists and health workers to identify these genera.

165. (3) syrinx
The sound box or vocal organ of birds is called the syrinx. It is located at the base of the trachea, where it branches into the bronchi. This structure allows birds to produce a wide range of complex sounds and songs without the use of vocal cords like those found in the human larynx. The syrinx is a unique avian adaptation, and its efficiency is what enables the diverse and elaborate vocalizations characteristic of many bird species.

166. (2) rhabditiform
The larval stage of Ascaris is known as the rhabditiform larva. Specifically, the second-stage rhabditiform larva is the infective form found within the egg. Once ingested by a host, it hatches and begins a migration through the circulatory and respiratory systems before returning to the intestine to mature. Other terms like cysticercus or hexacanth refer to larval stages of different parasites, such as tapeworms, making rhabditiform the specific identifier for the Ascaris life cycle.

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167. (4) Mature proglottides contain both male and female organs.
Taenia, commonly known as the tapeworm, is a hermaphroditic parasite. Each mature proglottid, or body segment, contains a complete set of both male and female reproductive organs. This allows for self-fertilization or cross-fertilization between different proglottids or even different worms. This reproductive strategy is highly efficient for an endoparasite living in the host's intestine. As the segments age and become gravid, they fill with eggs and are eventually shed from the worm's body.

168. (1) ascon type
The ascon type is the simplest and most primitive form of the canal system found in the phylum Porifera. It consists of a simple, thin-walled tube with a large central spongocoel. Water enters through ostia in the body wall and exits through a single osculum at the top. This type is typically found in small sponges like Leucosolenia. More complex types, such as sycon and leucon, involve folding and branching of the walls to increase surface area.

169. (2) platypus
The platypus is an egg-laying mammal, classified as a monotreme. While it possesses characteristic mammalian traits such as hair and mammary glands, it retains the ancestral vertebrate feature of laying leathery eggs. In contrast, kangaroos are marsupials that give birth to underdeveloped young, and whales are placental mammals. The platypus, along with the echidna, represents a unique evolutionary group that provides insight into the transition from reptilian to mammalian reproductive biology.

170. (2) metanephros
The kidney of an adult rabbit, like all mammals, is of the metanephros type. This is the most advanced and complex type of kidney found in vertebrates, developing from the posterior part of the embryonic nephrogenic tissue. It is highly efficient at filtering waste and concentrating urine, which is essential for terrestrial life. Pronephros and mesonephros are simpler kidney types that appear during the embryonic development of higher vertebrates or as the functional kidneys in lower vertebrates.

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171. (2) Radial symmetry
Adult echinoderms are characterized by radial symmetry, specifically pentamerous radial symmetry, where the body can be divided into five similar parts around a central axis. This is a defining feature of the phylum. While their larvae exhibit bilateral symmetry, the transition to radial symmetry occurs during metamorphosis into adulthood. Echinoderms also have a spiny skin and a water vascular system, but radial symmetry is their most prominent and distinctive morphological trait used in taxonomic identification.

172. (3) Musca
Musca, the common housefly, is regarded as one of the greatest mechanical carriers of diseases. It does not bite but spreads pathogens by picking them up on its legs and mouthparts from waste and then depositing them on food and surfaces. This can transmit a wide variety of illnesses, including typhoid, cholera, and dysentery. While other insects like lice or fleas can also carry diseases, the housefly's ubiquitous presence and feeding habits make it a major global health concern.

173. (3) ecdysone
Metamorphosis and molting in insects are primarily regulated by the hormone ecdysone, also known as the molting hormone. It is secreted by the prothoracic glands and triggers the shedding of the old exoskeleton (ecdysis) and the development of new tissues. This process is essential for growth and the transition between different life stages, such as from larva to pupa. Ecdysone works in conjunction with juvenile hormone to ensure the proper timing and sequence of these developmental changes.

174. (2) spicules
The classification of the phylum Porifera is primarily based on the composition and shape of their spicules, which are the structural elements that form the sponge's skeleton. Spicules can be made of calcium carbonate (calcareous) or silica (siliceous), or the skeleton may consist of spongin fibers. Depending on these materials, sponges are divided into different classes such as Calcarea, Hexactinellida, and Demospongiae. This skeletal architecture is the most consistent feature used by taxonomists to categorize sponges.

175. (1) flame cells
Flame cells, also known as protonephridia, are the specialized excretory structures found in flatworms like Taenia. These cells have a cluster of cilia that beat rhythmically, resembling a flickering flame, which helps to draw fluid and metabolic wastes from the body into a system of tubules. This primitive but effective system is also involved in osmoregulation. Other excretory structures like Malpighian tubules or green glands are found in different phyla such as arthropods, reflecting diverse evolutionary pathways.

176. (1) tapeworm
The bladderworm, or cysticercus, is a crucial larval stage in the life cycle of various tapeworms, such as Taenia solium. This stage typically develops in the muscle tissue of the intermediate host, such as a pig. It appears as a small, fluid-filled sac containing an invaginated scolex. When a primary host, like a human, ingests undercooked meat containing these cysticerci, the scolex evaginates and attaches to the intestinal wall to grow into an adult tapeworm.

177. (1) stratum corneum
Ecdysis, commonly known as molting, is the process of shedding the outermost layer of the skin or exoskeleton. In many vertebrates, this involves shedding the stratum corneum, which is the dead, keratinized outer layer of the epidermis. This allows for growth and the removal of worn-out tissue. In arthropods, ecdysis refers to the periodic shedding of the entire chitinous exoskeleton. In both cases, the process is essential for the organism's continued development and physical health.

178. (2) Antarctica
Penguins are flightless marine birds that are primarily found in the Southern Hemisphere, with their most iconic populations residing in Antarctica. They are highly adapted to cold environments, featuring thick layers of fat and specialized feathers for insulation. While they can be found on several Southern continents and islands, the vast ice shelves and nutrient-rich waters of the Antarctic region are the primary habitat for many species, where they form large breeding colonies.

179. (3) sand fly
Kala-azar (visceral leishmaniasis) and Oriental Sore (cutaneous leishmaniasis) are parasitic diseases spread by the bite of infected female sand flies. These tiny insects act as biological vectors, transmitting Leishmania protozoans between hosts. The sand fly typically inhabits warm, humid environments and is most active during the night. Controlling sand fly populations is a key strategy in reducing the incidence of these diseases in affected regions, as they are the primary mode of transmission to humans.

180. (1) excretory organs of insects
Malpighian tubules are the primary excretory and osmoregulatory organs found in most insects. They are a series of blind-ended tubes that branch off from the junction of the midgut and hindgut. These tubules actively transport nitrogenous wastes, primarily uric acid, and salts from the surrounding hemolymph into the gut for excretion. This efficient system allows insects to conserve water, which is a critical adaptation for their success in diverse terrestrial environments across the globe.

181. (1) absence of scolex hooks
Taenia saginata (the beef tapeworm) differs from Taenia solium (the pork tapeworm) primarily by the absence of scolex hooks. While both tapeworms have suckers on their scolex for attachment, only T. solium possesses a rostellum armed with a double row of hooks. Additionally, T. saginata is generally larger and has more complex uterine branching in its gravid proglottids. These morphological distinctions are essential for the accurate laboratory identification of these two common human parasitic infections.

182. (3) Taenia
The onchosphere is a larval stage found in the life cycle of tapeworms, such as Taenia. It is a six-hooked embryo (hexacanth) that develops within the egg. When the egg is ingested by a suitable intermediate host, the onchosphere hatches, penetrates the intestinal wall, and migrates to other tissues, where it develops into the next stage, the cysticercus. This developmental phase is a critical step in the transmission and continued survival of these complex parasitic flatworms.

183. (2) true placentation
Eutherians, or placental mammals, are characterized by the presence of a true placenta that facilitates a long and complex period of internal development. This organ allows for the

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efficient exchange of nutrients, gases, and wastes between the mother and the developing fetus. While other mammals like marsupials have a rudimentary placenta, the highly developed and functional placenta of eutherians is their defining feature. This reproductive strategy has allowed them to colonize almost every habitat on Earth.

184. (4) pectoral girdle/clavicles.
The wishbone, or furcula, in birds is formed by the fusion of the two clavicles from the pectoral girdle. This V-shaped bone acts as a spring that stores and releases energy during the wing stroke, aiding in the mechanics of flight. It is a unique skeletal adaptation found in almost all birds and some of their theropod dinosaur ancestors. The furcula provides crucial structural support and flexibility to the avian chest during the intense physical activity of flying.

185. (2) keel of sternum
The powerful flight muscles of birds are primarily attached to the keel, or carina, of the sternum (breastbone). This large, bony ridge provides an extensive surface area for the attachment of the pectoralis major and supracoracoideus muscles, which are responsible for the downstroke and upstroke of the wings, respectively. This specialized skeletal feature is a hallmark of flying birds (Neognathae) and is essential for providing the leverage needed for generating the force required for aerial flight.

186. (3) post-anal tail
A fundamental chordate character is the presence of a post-anal tail at some stage during the life cycle. This is an extension of the body that continues beyond the opening of the anus. While other features like gills can be found in non-chordate groups, and chitinous exoskeletons are typical of arthropods, the post-anal tail is a unique anatomical hallmark shared by all chordates, along with a notochord and a dorsal hollow nerve cord.

187. (1) oncosphere
The transfer of the tapeworm Taenia to its secondary (intermediate) host occurs in the form of the oncosphere. This stage is contained within the embryonated eggs that are passed in the feces of the primary host. When these eggs are ingested by cattle or pigs, the oncosphere hatches and uses its hooks to penetrate the intestinal wall. It then travels through the bloodstream to muscles, where it develops into a cysticercus, continuing the parasite's complex life cycle.

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188. (2) Scyphozoa
Jellyfish, such as the genus Aurelia, belong to the class Scyphozoa within the phylum Cnidaria. This class is characterized by having the medusa stage as the dominant and most conspicuous part of the life cycle. While they may have a small, reduced polyp stage, the large, bell-shaped, swimming medusae are the most familiar forms. In contrast, Hydrozoa often have more prominent polyps, and Anthozoa, like corals and anemones, lack a medusa stage entirely.

189. (4) Gambusia.
Gambusia, commonly known as the mosquitofish, is a small fish widely used in the biological control of mosquitoes. It is a highly effective larvivore, meaning it feeds voraciously on mosquito larvae and pupae in stagnant water. By introducing Gambusia into ponds, marshes, and drainage ditches, mosquito populations can be significantly reduced without the use of chemical pesticides. This environmentally friendly approach has been implemented globally to help combat mosquito-borne diseases like malaria and Zika virus.

190. (4) cetacea.
Most mammals possess a covering of hair on their skin, but members of the order Cetacea, which includes whales and dolphins, are a notable exception. These fully aquatic mammals have evolved smooth, hairless skin to reduce drag while swimming. Instead of hair, they rely on a thick layer of blubber for insulation in cold water. While some cetaceans may have a few vestigial bristles during their early development, as adults, they are functionally hairless, distinguishing them from most other mammals.

191. (2) heterocoelous
Bird vertebrae are typically heterocoelous, meaning the articular surfaces of the vertebral bodies are saddle-shaped. This unique arrangement provides a high degree of flexibility and strength, which is especially important in the neck, allowing birds to move their heads in a wide range of directions. This anatomical adaptation compensates for the relative rigidity of the rest of the avian spine and facilitates various behaviors such as preening, feeding, and maintaining balance during flight and perching.

192. (2) perching
The feet of the kingfisher are specifically modified for perching on branches near water sources. While many kingfishers dive to catch fish, their feet are not primarily adapted for wading or swimming but for gripping a lookout spot. They typically have syndactyl feet, where some toes are fused together, providing a stable grip. This allows them to remain steady while scanning the water for prey, reflecting a balance between their predatory lifestyle and their need for a secure vantage point.

193. (3) crop
Both male and female pigeons are capable of secreting "pigeon milk" from the lining of their crop. This nutritious substance is produced under the influence of the hormone prolactin and is used to feed their young (squabs) during the first few days after hatching. Unlike mammalian milk produced by mammary glands, pigeon milk is composed of shed, protein-rich cells from the crop wall. This unique reproductive adaptation ensures that the young receive essential nutrients for rapid early growth.

194. (3) blind snake
Typhlops is a genus of snakes commonly known as blind snakes. They are characterized by their small, cylindrical bodies, smooth scales, and vestigial eyes that are covered by scales, making them nearly blind. These snakes are primarily burrowing animals, living in soil or leaf litter where they feed on small invertebrates like ants and termites. Their specialized morphology and behavior reflect an adaptation to a subterranean lifestyle, distinguishing them from more familiar surface-dwelling snake species.

195. (3) mud puppy
Necturus is a genus of aquatic salamanders commonly referred to as mud puppies. They are characterized by being paedomorphic, meaning they retain several larval features as adults, most notably their prominent external gills. Mud puppies live entirely in water, inhabiting various freshwater environments like lakes and streams. They are distinct from other amphibians by their lifelong aquatic existence and the presence of these red, feathery gills, which they use for respiration throughout their entire life.

196. (2) Bombina
The fire-bellied toad is the common name for the genus Bombina. These small amphibians are known for their bright, warning coloration on their undersides, which they display to deter predators when threatened. While their dorsal side is usually camouflaged, the vibrant red or orange belly serves as a signal of their toxicity. They are a well-known group within the amphibian world, often kept in captivity and studied for their unique defensive behaviors and colorful skin patterns.

197. (3) Tortoise
The tortoise is not a true amphibian; instead, it belongs to the class Reptilia. While many amphibians like frogs, toads, and salamanders have moist skin and typically undergo an aquatic larval stage, tortoises have dry, scaly skin and lay leathery eggs on land. They are fully terrestrial and belong to a different evolutionary lineage than the amphibians. Distinguishing between these groups requires identifying key features such as skin texture, reproductive methods, and developmental life cycles.

198. (2) Teredo
Teredo, commonly known as the shipworm, is a specialized wood-boring bivalve mollusc. Despite its worm-like appearance, it possesses small shells at its anterior end that it uses to rasp into submerged wood, such as ship hulls and piers. This behavior can cause significant structural damage. Shipworms are highly adapted to this niche, possessing symbiotic bacteria that help them digest cellulose. They represent a unique and ecologically significant group within the diverse phylum of Mollusca.

199. (1) Tubipora
The Organ Pipe Coral is the common name for the genus Tubipora, which belongs to the class Anthozoa. It is characterized by its distinctive bright red skeleton composed of numerous calcareous tubes fused together by horizontal platforms. This structure resembles a series of organ pipes, providing protection for the polyps while contributing to the formation of reefs in tropical oceans. Its unique skeletal architecture makes it easily identifiable among the diverse types of coral species found globally.

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CHAPTER 05
Morphology of Flowering Plants

2026 (RE-NEET)

1. Phyllotaxy is the pattern of arrangement of:
(1) fruits
(2) sepals
(3) leaves
(4) flowers

2026 (RE-NEET)

2. Match List-I with List-II:
List-I
A. Marginal placentation;
B. Axile;
C. Parietal;
D. Free central.
List-II
I. Argemone,
II. Tomato,
III. Primrose,
IV. Pea
Choose the correct answer from the options given below :
(1) A-IV, B-III, C-I, D-II
(2) A-IV, B-II, C-I, D-III
(3) A-II, B-IV, C-I, D-III
(4) A-IV, B-II, C-III, D-I

2026 (RE-NEET)

3. Which are characteristic features of Solanaceae family?
(a) Flowers bisexual and actinomorphic;
(b) Calyx of five united sepals;
(c) Androecium of five epipetalous stamens;
(d) Ovary is inferior.
Choose the correct answer from the options given below:
(1) (a) and (b) only
(2) (b), (c) and (d) only
(3) (a), (b) and (c) only
(4) (d) only

2026 (CANCELLED)

4. Which of the following floral formula is the correct floral formula of Solanaceae family?
(1) (+) (bisexual) $K_{(5)}\ C_{(5)}\ A_5\ G_{(2)}$
(2) (+) (bisexual) $K_{(5)}\ C_{(5)}\ A_5\ G_{(2)}$ [gamopetalous corolla, superior bicarpellary ovary]
(3) (+) (bisexual) $K_5\ C_5\ A_5\ G_{(2)}$
(4) (+) (bisexual) $K_5\ C_{(5)}\ A_5\ G_{(2)}$

2026 (CANCELLED)

5. In racemose inflorescence:
(1) the main axis terminates in a flower
(2) flowers are solitary
(3) the growth is limited
(4) flowers are borne in an acropetal succession

2026 (CANCELLED)

6. Match List I with List II:
List I (Placentation):
A. Marginal
B. Axile
C. Parietal
D. Basal
List II (Example):
I. Mustard
II. Pea
III. Marigold
IV. Lemon
(1) A-II, B-IV, C-I, D-III
(2) A-I, B-III, C-II, D-IV
(3) A-III, B-I, C-IV, D-II
(4) A-IV, B-III, C-I, D-III

2025

7. Which of the following is an example of a zygomorphic flower?
(1) Pea
(2) Chilli
(3) Petunia
(4) Datura

2025

8. In the seeds of cereals the outer covering of endosperm separates the embryo by a protein-rich layer called
(1) integument
(2) aleurone layer
(3) coleoptile
(4) coleorhiza.

2025

9. Given below are two statements:
Statement I: In a floral formula % stands for zygomorphic nature of the flower, and $\bar{G}$ stands for inferior ovary.
Statement II : In a floral formula $\oplus$ stands for actinomorphic nature of the flower and $\underline{G}$ stands for superior ovary.

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In the light of the above statements, choose the correct answer from the options given below:
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

RE-EXAM 2024

10. Match List-I with List-II.

	List-I		List-II
A.	Vexillary aestivation	I.	Brinjal
B.	Epipetalous stamens	II.	Peach
C.	Epiphyllous stamens	III.	Pea
D.	Perigynous flower	IV.	Lily

Choose the correct answer from the options given below.
(1) A-III, B-I, C-IV, D-II
(2) A-III, B-IV, C-I, D-II
(3) A-III, B-II, C-I, D-IV
(4) A-II, B-I, C-IV, D-III

RE-EXAM 2024

11. Match List-I with List-II.

	List-I		List-II
A.	China rose	I.	Free central
B.	Mustard	II.	Basal
C.	Primrose	III.	Axile
D.	Marigold	IV.	Parietal

Choose the correct answer from the options given below.
(1) A-IV, B-III, C-II, D-I
(2) A-II, B-III, C-IV, D-I
(3) A-III, B-IV, C-I, D-II
(4) A-III, B-IV, C-II, D-I

2024

12. Which of the following is an example of actinomorphic flower?
(1) Datura
(2) Cassia
(3) Pisum
(4) Sesbania

2024

13. Match List I with List II.

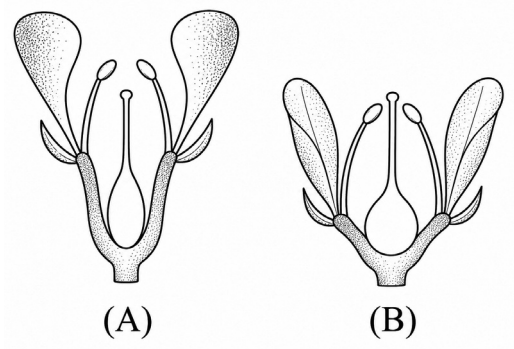
List I (Types of stamens)			List II (Example)
A.	Monoadelphous	I.	Citrus
B.	Diadelphous	II.	Pea
C.	Polyadelphous	III.	Lily
D.	Epiphyllous	IV.	China-rose

Choose the correct answer from the options given below.
(1) A-IV, B-II, C-I, D-III
(2) A-IV, B-I, C-II, D-III
(3) A-I, B-II, C-IV, D-III
(4) A-III, B-I, C-IV, D-II

2024

14. Identify the type of flowers based on the position of calyx, corolla and androecium with respect to the ovary from the given figures (A) and (B).

NODIA



(1) (A) Epigynous; (B) Hypogynous
(2) (A) Hypogynous; (B) Epigynous
(3) (A) Perigynous; (B) Epigynous
(4) (A) Perigynous; (B) Perigynous

2024

15. Match List I with List II.

	List-I		List-II
A.	Rose	I.	Twisted aestivation
B.	Pea	II.	Perigynous flower
C.	Cotton	III.	Drupe
D.	Mango	IV.	Marginal placentation

Choose the correct answer from the options given below.
(1) A-II, B-IV, C-I, D-III
(2) A-I, B-II, C-III, D-IV
(3) A-IV, B-III, C-II, D-I
(4) A-II, B-III, C-IV, D-I

RE-EXAM 2024

16. Which of the following examples show monocarpellary, unilocular ovary with many ovules?

A. Sesbania
B. Brinjal
C. Indigofera
D. Tobacco
E. Asparagus

Choose the correct answer from the options given below.

(1) B and E only
(2) C, D and E only
(3) A, B and D only
(4) A and C only

2023

17. Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R) :

Assertion (A) : A flower is defined as modified shoot wherein the shoot apical meristem changes to floral meristem.

Reason (R) : Internode of the shoot gets condensed to produce different floral appendages laterally at successive nodes instead of leaves.

In the light of the above statements, choose the correct answer from the options given below :

(1) (A) is true but (R) is false.
(2) (A) is false but (R) is true.
(3) Both (A) and (R) are true and (R) is the correct explanation of (A).
(4) Both (A) and (R) are true but (R) is not the correct explanation of (A).

Manipur NEET 2023

18. In Calotropis, aestivation is

(1) valvate
(2) vexillary
(3) imbricate
(4) twisted.

Manipur NEET 2023

19. In a pea flower, five petals are arranged in a specialised manner with one posterior, two lateral and two anterior. These are named as _____, _____ and _____ respectively.

(1) Keel, Wings and Standard
(2) Vexillum, Keel and Standard
(3) Keel, Standard and Carina
(4) Standard, Wings and Keel

Manipur NEET 2023

20. Match List I with List II.

List-I (Type of flower)			List-II (Example)
A.	Zygomorphic	I.	Mustard
B.	Hypogynous	II.	Plum
C.	Perigynous	III.	Cassia
D.	Epigynous	IV.	Cucumber

Select the correct option.

(1) (A)-(I), (B)-(II), (C)-(IV), (D)-(III)
(2) (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
(3) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)
(4) (A)-(III), (B)-(I), (C)-(II), (D)-(IV)

2023

21. Axile placentation is observed in

(1) tomato, Dianthus and pea
(2) China rose, Petunia and lemon
(3) mustard, cucumber and primrose
(4) China rose, beans and lupin.

2023

22. Family Fabaceae differs from Solanaceae and Liliaceae. With respect to the stamens, pick out the characteristics specific to family Fabaceae but not found in Solanaceae or Liliaceae.

(1) Monoadelphous and monothecous anthers
(2) Epiphyllous and dithecous anthers
(3) Diadelphous and dithecous anthers
(4) Polyadelphous and epipetalous stamens

2022

23. Identify the correct set of statements :

A. The leaflets are modified into pointed hard thorns in Citrus and Bougainvillea
B. Axillary buds form slender and spirally coiled tendrils in cucumber and pumpkin
C. Stem is flattened and fleshy in Opuntia and modified to perform the function of leaves
D. Rhizophora shows vertically upward growing roots that help to get oxygen for respiration
E. Subaerially growing stems in grasses and strawberry help in vegetative propagation.

Choose the correct answer from the options given below :

(1) (B) and (C) only
(2) (A) and (D) only
(3) (B), (C), (D) and (E) only
(4) (A), (B), (D) and (E) only

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2022

24. The flowers are zygomorphic in
A. Mustard
B. Gulmohar
C. Cassia
D. Datura
E. Chilly
Choose the correct answer from the options given below :
(1) (A), (B), (C) only
(2) (B), (C) only
(3) (D), (E) only
(4) (C), (D), (E) only

2022

25. Which one of the following plants shows vexillary aestivation and diadelphous stamens?
(1) Colchicum autumnale
(2) Pisum sativum
(3) Allium cepa
(4) Solanum nigrum

2021

26. Diadelphous stamens are found in
(1) China rose and citrus
(2) China rose
(3) citrus
(4) pea.

2021

27. Match Column - I with Column - II.

	Column I		Column II
(p)	% ♂ ♀ $K_{(5)}$ $C_{1+2+(2)}$ $A_{(9)+1}$ $\underline{G}_1$	(i)	Brassicaceae
(q)	⊕ ♂ ♀ $K_{(5)}$ $C_{(5)}$ A_5 $\underline{G}_{(2)}$	(ii)	Liliaceae
(r)	Br ⊕ ♂ ♀ $P_{(3+3)}$ A_{3+3} $\underline{G}_{(3)}$	(iii)	Fabaceae
(s)	⊕ ♂ ♀ K_{2+2} C_4 A_{2+4} $\underline{G}_{(2)}$	(iv)	Solanaceae

Select the correct answer from the options given below.
(1) (p)-(iv), (q)-(ii), (r)-(i), (s)-(iii)
(2) (p)-(iii), (q)-(iv), (r)-(ii), (s)-(i)
(3) (p)-(i), (q)-(ii), (r)-(iii), (s)-(iv)
(4) (p)-(ii), (q)-(iii), (r)-(iv), (s)-(i)

2020

28. The roots that originate from the base of the stem are
(1) fibrous roots
(2) primary roots
(3) prop roots
(4) lateral roots.

2020

29. Ray florets have
(1) inferior ovary
(2) superior ovary
(3) hypogynous ovary
(4) half inferior ovary.

2020

30. The ovary is half inferior in
(1) brinjal
(2) mustard
(3) sunflower
(4) plum.

2020

31. The body of the ovule is fused within the funicle at
(1) hilum
(2) micropyle
(3) nucellus
(4) chalaza.

2019

32. Placentation in which ovules develop on the inner wall of the ovary or in peripheral part, is
(1) free central
(2) basal
(3) axile
(4) parietal.

NODIA

Odisha NEET 2019

33. Match the placental types (column-I) with their examples (column-II).

	Column I		Column II
(A)	Basal	(i)	Mustard
(B)	Axile	(ii)	China rose
(C)	Parietal	(iii)	Dianthus
(D)	Free central	(iv)	Sunflower

Choose the correct answer from the following options.
(1) (A)-(ii), (B)-(iii), (C)-(iv), (D)-(i)
(2) (A)-(i), (B)-(ii), (C)-(iii), (D)-(iv)
(3) (A)-(iv), (B)-(ii), (C)-(i), (D)-(iii)
(4) (A)-(iii), (B)-(iv), (C)-(i), (D)-(ii)

2018

34. Sweet potato is a modified
(1) stem
(2) adventitious root
(3) tap root
(4) rhizome.

2017

35. In Bougainvillea, thorns are the modifications of
(1) adventitious root
(2) stem
(3) leaf
(4) stipules.

2017

36. Coconut fruit is a
(1) berry
(2) nut
(3) capsule
(4) drupe.

2017

37. The morphological nature of the edible part of coconut is
(1) cotyledon
(2) endosperm
(3) pericarp
(4) perisperm.

NEET-I 2016

38. Which of the following is not a stem modification?
(1) Tendrils of cucumber
(2) Flattened structures of Opuntia
(3) Pitcher of Nepenthes
(4) Thorns of citrus

NEET-I 2016

39. Stems modified into flat green organs performing the functions of leaves are known as
(1) phylloclades
(2) scales
(3) cladodes
(4) phyllodes.

NEET-II 2016

40. The term 'polyadelphous' is related to
(1) gynoecium
(2) androecium
(3) corolla
(4) calyx.

NEET-II 2016

41. How many plants among Indigofera, Sesbania, Salvia, Allium, Aloe, mustard, groundnut, radish, gram and turnip have stamens with different lengths in their flowers?
(1) Three (2) Four
(3) Five (4) Six

NEET-II 2016

42. Radial symmetry is found in the flowers of
(1) Brassica (2) Trifolium
(3) Pisum (4) Cassia.

NEET-II 2016

43. Free central placentation is found in
(1) Dianthus
(2) Argemone
(3) Brassica
(4) Citrus.

NEET-I 2016

44. The standard petal of a papilionaceous corolla is also called
(1) vexillum
(2) corona
(3) carina
(4) pappus.

NEET-I 2016

45. Cotyledon of maize grain is called
(1) coleoptile
(2) scutellum
(3) plumule
(4) coleorhiza.

NEET-I 2016

46. Tricarpellary, syncarpous gynoecium is found in flowers of
(1) Fabaceae
(2) Poaceae
(3) Liliaceae
(4) Solanaceae

2015

47. Roots play insignificant role in absorption of water in
(1) pea
(2) wheat
(3) sunflower
(4) Pistia.

2015 Cancelled

48. Leaves become modified into spines in
(1) onion
(2) silk cotton
(3) Opuntia
(4) pea.

2015

49. Among China rose, mustard, brinjal, potato, guava, cucumber, onion and tulip, how many plants have superior ovary?
(1) Three
(2) Four
(3) Five
(4) Six

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2015

50. Axile placentation is present in
(1) pea
(2) Argemone
(3) Dianthus
(4) lemon.

2015 Cancelled

51. Keel is the characteristic feature of flower of
(1) Aloe
(2) tomato
(3) tulip
(4) Indigofera.

2015

52. The wheat grain has an embryo with one large, shield shaped cotyledon known as
(1) scutellum
(2) coleoptile
(3) epiblast
(4) coleorhiza.

2015 Cancelled

53. $\oplus\ \male\ K_{(5)}\ C_{(5)}\ A_5\ \underline{G}_{(2)}$ is the floral formula of
(1) Petunia
(2) Brassica
(3) Allium
(4) Sesbania.

2014

54. An example of edible underground stem is
(1) carrot
(2) groundnut
(3) sweet potato
(4) potato.

2014

55. When the margins of sepals or petals overlap one another without any particular direction, the condition is termed as
(1) vexillary
(2) imbricate
(3) twisted
(4) valvate.

2014

56. Placenta and pericarp are both edible portions in
(1) apple
(2) banana
(3) tomato
(4) potato.

2014

57. An aggregate fruit is one which develops from
(1) multicarpellary syncarpous gynoecium
(2) multicarpellary apocarpous gynoecium
(3) complete inflorescence
(4) multicarpellary superior ovary.

2014

58. Which one of the following statements is correct?
(1) The seed in grasses is not endospermic.
(2) Mango is a parthenocarpic fruit.
(3) A proteinaceous aleurone layer is present in maize grain.
(4) A sterile pistil is called a staminode.

NODIA

Karnataka NEET 2013

59. How many plants among China rose, Ocimum, sunflower, mustard, Alstonia, guava, Calotropis and Nerium (oleander) have opposite phyllotaxy?
(1) Three
(2) Four
(3) Five
(4) Two

Karnataka NEET 2013

60. Inflorescence is racemose in
(1) brinjal
(2) tulip
(3) Aloe
(4) soybean.

Karnataka NEET 2013

61. In a cymose inflorescence the main axis
(1) has unlimited growth
(2) bears a solitary flower
(3) has unlimited growth but lateral branches end in flowers
(4) terminates in a flower.

2013

62. Among bitter gourd, mustard, brinjal, pumpkin, china rose, lupin, cucumber, sunhemp, gram, guava, bean, chilli, plum, Petunia, tomato, rose, Withania, potato, onion, Aloe and tulip how many plants have hypogynous flower?
(1) Fifteen
(2) Eighteen
(3) Six
(4) Ten

2013

63. In China rose, the flowers are
(1) zygomorphic, hypogynous with imbricate aestivation
(2) zygomorphic, epigynous with twisted aestivation
(3) actinomorphic, hypogynous with twisted aestivation
(4) actinomorphic, epigynous with valvate aestivation.

Karnataka NEET 2013

64. Among flowers of Calotropis, tulip, Sesbania, Asparagus, Colchicum, sweet pea, Petunia, Indigofera, mustard, soybean, tobacco and groundnut, how many plants have corolla with valvate aestivation?
(1) Six
(2) Seven
(3) Eight
(4) Five

2012

65. Phyllode is present in
(1) Asparagus
(2) Euphorbia
(3) Australian Acacia
(4) Opuntia.

2012

66. Cymose inflorescence is present in
(1) Solanum
(2) Sesbania
(3) Trifolium
(4) Brassica.

2012

67. Placentation in tomato and lemon is
(1) parietal
(2) free central
(3) marginal
(4) axile.

2012

68. The gynoecium consists of many free pistils in flowers of
(1) Aloe
(2) tomato
(3) Papaver
(4) Michelia.

Mains 2012

69. How many plants in the list given below have marginal placentation?
Mustard, Gram, Tulip, Asparagus, Arhar, Sunhemp, Chilli, Colchicum, Onion, Moong, Pea, Tobacco, Lupin
(1) Four
(2) Five
(3) Six
(4) Three

2012

70. How many plants in the list given below have composite fruits that develop from an inflorescence?
Walnut, poppy, radish, fig, pineapple, apple, tomato, mulberry
(1) Four
(2) Five
(3) Two
(4) Three

2012

71. The coconut water and the edible part of coconut are equivalent to
(1) endosperm
(2) endocarp
(3) mesocarp
(4) embryo.

2012

72. Vexillary aestivation is characteristic of the Family
(1) Fabaceae
(2) Asteraceae
(3) Solanaceae
(4) Brassicaceae.

Mains 2011

73. Sweet potato is homologous to
(1) potato
(2) Colocasia
(3) ginger
(4) turnip.

Mains 2011

74. Whorled, simple leaves with reticulate venation are present in
(1) Calotropis
(2) neem
(3) China rose
(4) Alstonia.

2011

75. Flowers are zygomorphic in
(1) mustard
(2) gulmohar
(3) tomato
(4) Datura.

2011

76. The ovary is half inferior in flowers of
(1) peach
(2) cucumber
(3) cotton
(4) guava.

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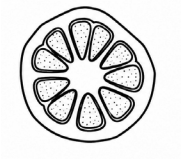
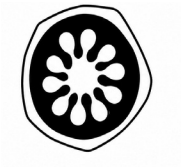
Mains 2011

77. Which one of the following figures represents the placentation in Dianthus?

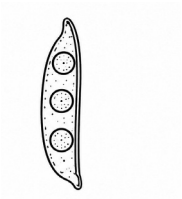
(1)



(2)



(3)



(4)

2011

78. A drupe develops in
(1) mango
(2) wheat
(3) pea
(4) tomato.

2011

79. Which one of the following statements is correct?
(1) In tomato, fruit is a capsule.
(2) Seeds of orchids have oil-rich endosperm.
(3) Placentation in primose is basal.
(4) Flower of tulip is a modified shoot.

2011

80. The correct floral formula of chilli is
(1) $\oplus\ \male\female\ K_{(5)}\ C_5\ A_5\ \underline{G}_{(2)}$
(2) $\oplus\ \male\female\ K_{(5)}\ C_{(5)}\ A_5\ \underline{G}_{(2)}$
(3) $\oplus\ \male\female\ K_{(5)}\ C_{(5)}\ A_{(5)}\ \underline{G}_2$
(4) $\oplus\ \male\female\ K_5\ C_5\ A_{(5)}\ \underline{G}_2$.

Mains 2010

81. Which one of the following is a xerophytic plant in which the stem is modified into the flat green and succulent structure?
(1) Opuntia
(2) Casuarina
(3) Hydrilla
(4) Acacia

2010

82. In unilocular ovary with a single ovule, the placentation is
(1) marginal
(2) basal
(3) free central
(4) axile.

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2010

83. Keel is characteristic of the flowers of
(1) gulmohur
(2) Cassia
(3) Calotropis
(4) bean.

2010

84. Ovary is half inferior in the flowers of
(1) guava
(2) plum
(3) brinjal
(4) cucumber.

2010

85. The technical term used for the androecium in a flower of China rose (Hibiscus rosa sinensis) is
(1) monadelphous
(2) diadelphous
(3) polyandrous
(4) polyadelphous.

Mains 2010

86. Aestivation of petals in the flower of cotton is correctly shown in

(1)

(2)

(3)

(4)

2010

87. The scutellum observed in a grain of wheat or maize is comparable to which part of the seed in other monocotyledons?
(1) Cotyledon
(2) Endosperm
(3) Aleurone layer
(4) Plumule

Mains 2010

88. The correct floral formula of soybean is
(1) % ♀♂ $K_{(5)}\ C_{1+(2)+2}\ A_{(9)+1}\ \underline{G}_{1}$
(2) % ♀♂ $K_{5}\ C_{1+(2)+2}\ A_{(9)+1}\ \underline{G}_{1}$
(3) % ♀♂ $K_{(5)}\ C_{1+2+(2)}\ A_{(9)+1}\ \underline{G}_{1}$
(4) % ♀♂ $K_{(5)}\ C_{1+2+(2)}\ A_{1+(9)}\ \underline{G}_{1}$

Mains 2010

89. Consider the following four statements (i), (ii), (iii) and (iv) and select the right option for two correct statements.
(i) In vexillary aestivation, the large posterior petal is called-standard, two lateral ones are wings and two small anterior petals are termed keel.
(ii) The floral formula for Liliaceae is Br ⊕ ♀♂ $P_{(3+3)}\ A_{3+3}\ \underline{G}_{(3)}$
(iii) In pea flower the stamens are monodelphous.
(iv) The floral formula for Solanaceae is ⊕ ♀♂ $K_{(3)}\ C_{(3)}\ A_{(4)}\ \underline{G}_{(2)}$.
The correct statements are
(1) (i) and (iii)
(2) (i) and (ii)
(3) (ii) and (iii)
(4) (iii) and (iv).

2009

90. An example of axile placentation is
(1) Dianthus
(2) lemon
(3) marigold
(4) Argemone.

2009

91. A fruit developed from hypanthodium inflorescence is called
(1) sorosis
(2) syconus
(3) caryopsis
(4) hesperidium.

2009

92. Cotyledons and testa respectively are edible parts in
(1) walnut and tamarind
(2) french bean and coconut
(3) cashew nut and litchi
(4) groundnut and pomegranate.

2009

93. An example of a seed with endosperm, perisperm, and caruncle is
(1) coffee
(2) lily
(3) castor
(4) cotton.

2009

94. The floral formula ⊕ ♀♂ $K_{(5)}\ C_{(5)}\ A_{5}\ \underline{G}_{(2)}$ is that of
(1) soybean
(2) sunhemp
(3) tobacco
(4) tulip.

2008

95. Replum is present in the ovary of flower of
(1) sunflower
(2) pea
(3) lemon
(4) mustard.

2008

96. The fleshy receptacle of syconus of fig encloses a number of
(1) berries
(2) mericarps
(3) achenes
(4) samaras.

2008

97. Dry indehiscent single-seeded fruit formed from bicarpellary syncarpous inferior ovary is
(1) berry
(2) cremocarp
(3) caryopsis
(4) cypsela.

2008

98. The fruit is chambered, developed from inferior ovary and has seeds with succulent testa in
(1) guava
(2) cucumber
(3) pomegranate
(4) orange.

2008

99. Endosperm is consumed by developing embryo in the seed of
(1) pea
(2) maize
(3) coconut
(4) castor.

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2006

100. Long filamentous threads protruding at the end of a young cob of maize are
(1) hairs
(2) anthers
(3) styles
(4) ovaries.

2006

101. Pineapple (Ananas) fruit develops from
(1) a multilocular monocarpellary flower
(2) a unilocular polycarpellary flower
(3) a multipistillate syncarpous flower
(4) a cluster of compactly borne flowers on a common axis.

2006

102. In which of the following fruits, the edible part is the aril ?
(1) Litchi
(2) Custard apple
(3) Pomegranate
(4) Orange

2006

103. Pentamerous actinomorphic flowers, bicarpellary ovary with oblique septa, and fruit capsule or berry, are characteristic features of
(1) Liliaceae
(2) Asteraceae
(3) Brassicaceae
(4) Solanaceae.

2005

104. Which of the following represents the edible part of the fruit of litchi?
(1) Mesocarp
(2) Endocarp
(3) Pericarp
(4) Juicy aril

2004

105. Edible part of mango is
(1) endocarp
(2) receptacle
(3) epicarp
(4) mesocarp.

2003

106. Juicy hair-like structures observed in the lemon fruit develop from
(1) exocarp
(2) mesocarp
(3) endocarp
(4) mesocarp and endocarp.

2003

107. The aleurone layer in maize grain is specially rich in
(1) proteins
(2) starch
(3) lipids
(4) auxins.

2002

108. Geocarpic fruit is
(1) potato
(2) peanut
(3) onion
(4) garlic.

2002

109. Edible part in mango is
(1) mesocarp
(2) epicarp
(3) endocarp
(4) epidermis.

2001

110. What is the eye of potato?
(1) Axillary bud
(2) Accessory bud
(3) Adventitious bud
(4) Apical bud

2001

111. Which is correct pair for edible part?
(1) Tomato-thalamus
(2) Maize-cotyledons
(3) Guava-mesocarp
(4) Date palm-mesocarp

2001

112. Edible part of banana is
(1) epicarp
(2) mesocarp and less developed endocarp
(3) endocarp and less developed mesocarp
(4) epicarp and mesocarp.

2001

113. Bicarpellary gynoecium and oblique ovary occurs in
(1) mustard
(2) banana
(3) Pisum
(4) brinjal.

2001

114. Tetradynamous conditions occur in
(1) Cruciferae
(2) Malvaceae
(3) Solanaceae
(4) Liliaceae.

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2000

115. Pneumatophores are found in
(1) the vegetation which is found in marshy and saline lake
(2) the vegetation which found in acidic soil
(3) xerophytes
(4) epiphytes.

2000

116. Hair found in the inflorescence of Zea mays are the modification of
(1) style
(2) stigma
(3) spathe
(4) filaments.

2000

117. Geocarpic fruit is
(1) carrot
(2) radish
(3) groundnut
(4) turnip.

2000

118. Which is expressing right appropriate pairing?
(1) Brassicaceae - sunflower
(2) Malvaceae - cotton
(3) Papilionaceae - Catechu
(4) Liliaceae - wheat

1999

119. The plant, which bears clinging roots, is
(1) screw pine
(2) Podostemon
(3) Trapa
(4) orchid.

1999

120. Angiosperm, to which the largest flowers belong, is
(1) total root parasite
(2) partial root parasite
(3) total stem parasite
(4) partial stem parasite.

1998

121. Floral features are chiefly used in angiosperm identification because
(1) flowers can be safely pressed
(2) reproductive parts are more stable and conservative than vegetative parts
(3) flowers are nice to work with
(4) flowers are of various colours.

1997

122. Which plant will lose its economic value, if its fruits are produced by induced parthenocarpy?
(1) Orange
(2) Banana
(3) Grape
(4) Pomegranate

1996

123. Which of the following is a 'true fruit'?
(1) Banana
(2) Fig
(3) Apple
(4) Pear

1994

124. Hypanthodium is a specialised type of
(1) fruit
(2) inflorescence
(3) thalamus
(4) ovary.

1993

125. Pulses are obtained from
(1) Fabaceae
(2) Asteraceae
(3) Poaceae
(4) Solanaceae.

1992

126. Epipetalous stamens with free filaments and fused anthers occur in
(1) Asteraceae
(2) Solanaceae
(3) Liliaceae
(4) Poaceae.

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1992, 1989

127. Floral formula of tomato/tobacco is
(1) $\oplus\ \female\male\ K_{4-5}\ A_{10}\ G_{(2)}$
(2) $\oplus\ \female\male\ K_{2+2}\ C_4\ A_{2+4}\ G_1$
(3) $\oplus\ \female\male\ P_2\ A_3\ G_1$
(4) $\oplus\ \female\male\ K_{(5)}\ C_{(5)}\ A_5\ \underline{G}_{(2)}$.

1991

128. Velamen is found in
(1) roots of screwpine
(2) aerial and terrestrial roots of orchids
(3) leaves of Ficus elastica
(4) aerial roots of orchids.

1991

129. Fruit of Mangifera indica is
(1) berry (2) drupe
(3) capsule (4) siliqua.

1991

130. $\oplus$ ♀ $K_{(5)}$ $C_{(5)}$ A_5 $\underline{G}_{(2)}$ is floral formula of
(1) Liliaceae
(2) Solanaceae
(3) Asteraceae
(4) Fabaceae.

1991

131. Epipetalous and syngenesious stamens occur in
(1) Solanaceae
(2) Brassicaceae
(3) Fabaceae
(4) Asteraceae.

1991

132. A family delimited by type of inflorescence is
(1) Fabaceae
(2) Asteraceae
(3) Solanaceae
(4) Liliaceae.

1991

133. Syngenesious condition is found in
(1) Asteraceae
(2) Labiatae
(3) Solanaceae
(4) Fabaceae.

1990

134. New banana plants develop from
(1) rhizome
(2) sucker
(3) stolon
(4) seed.

1990

135. In groundnut the food/oil reserve is present in
(1) epicarp
(2) mesocarp
(3) endosperm
(4) cotyledons.

1990

136. Oil reserve of groundnut is present in
(1) embryo
(2) cotyledons
(3) endosperm
(4) underground tubers.

1989

137. Mango juice is obtained from
(1) epicarp
(2) mesocarp
(3) endocarp
(4) pericarp and thalamus.

1988

138. Fruit of groundnut is
(1) legume
(2) caryopsis
(3) berry
(4) nut.

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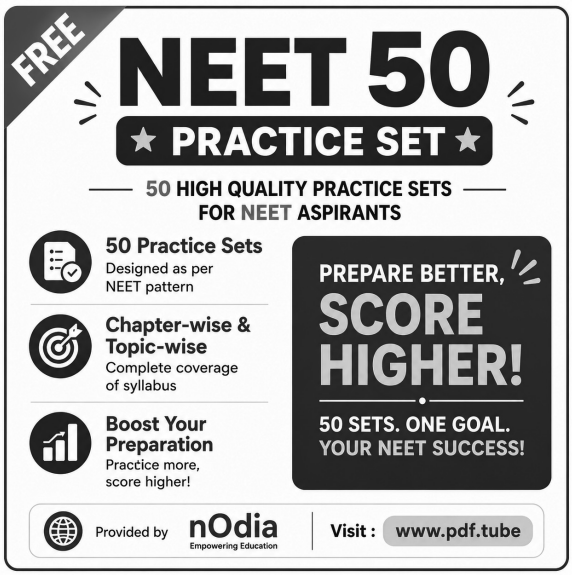

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ANSWERS

1. (3) leaves
Phyllotaxy refers to the pattern of arrangement of leaves on the stem or branch. It may be alternate, opposite or whorled. This arrangement ensures leaves are positioned to receive maximum sunlight for photosynthesis.

2. (2) A-IV, B-II, C-I, D-III
Marginal placentation occurs in pea (IV), axile in tomato (II), parietal in Argemone (I), and free central in Primrose (III). This gives A-IV, B-II, C-I, D-III.

3. (3) (a), (b) and (c) only
In Solanaceae, flowers are bisexual and actinomorphic (a), the calyx has five united sepals (b), and the androecium has five epipetalous stamens (c). The ovary is superior, not inferior, so (d) is wrong.

4. (2) (+) (bisexual) $K_{(5)}\ C_{(5)}\ A_5\ G_{(2)}$
Solanaceae flowers are actinomorphic and bisexual with a gamosepalous calyx of five fused sepals $K_{(5)}$, gamopetalous corolla of five fused petals $C_{(5)}$, five epipetalous stamens A_5, and a bicarpellary syncarpous superior ovary $G_{(2)}$. This matches the standard Solanaceae floral formula.

5. (4) flowers are borne in an acropetal succession
In a racemose inflorescence the main axis grows indefinitely and does not end in a flower. Flowers are arranged in acropetal succession, meaning older flowers are at the base and younger ones towards the apex. The growth of the main axis is unlimited (indeterminate).

6. (1) A-II, B-IV, C-I, D-III
Marginal placentation occurs in pea, axile in lemon (and citrus), parietal in mustard, and basal in marigold (sunflower family). This gives the correct matching A-II, B-IV, C-I, D-III, where each placentation type is paired with its representative plant example.

7. (1) Pea
Zygomorphic flowers show bilateral symmetry, meaning they can be divided into two equal halves only in one particular vertical plane. This characteristic is typically found in members of the Fabaceae family, such as pea, bean, and gulmohar. In contrast, actinomorphic flowers like chili and datura exhibit radial symmetry and can be divided into identical halves through any radial plane.

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8. (2) aleurone layer
In monocotyledonous seeds like cereals, the endosperm is the primary food storage tissue and is usually bulky. The outer covering of the endosperm is a specialized proteinaceous layer known as the aleurone layer. This layer effectively separates the embryo from the endosperm and plays a crucial role during seed germination by secreting enzymes that break down stored starch into sugars.

9. (3) Both statement I and statement II are correct.
Floral formulas use specific symbols to represent botanical characteristics. The percent symbol denotes zygomorphic symmetry, while the circle with a cross represents actinomorphic symmetry. Regarding the gynoecium, a line above the letter G signifies an inferior ovary, whereas a line below the letter G indicates a superior ovary. Therefore, both descriptions provided regarding floral symmetry and ovary position are technically accurate.

10. (1) A-III, B-I, C-IV, D-II
Vexillary aestivation is a characteristic feature of the pea flower within the Fabaceae family. Epipetalous stamens, where filaments are attached to petals, are found in brinjal. Epiphyllous stamens occur when stamens are attached to the perianth, as seen in lily. Perigynous flowers, where the ovary is situated in the center and other floral parts are located on the rim, occur in peach.

11. (3) A-III, B-IV, C-I, D-II
Axile placentation occurs in China rose where ovules are attached to a central axis in a multilocular ovary. Parietal placentation is found in mustard as ovules develop on the inner wall. Primrose exhibits free central placentation where ovules are borne on a central axis without septa. Marigold shows basal placentation characterized by a single ovule attached at the base.

12. (1) Datura
Actinomorphic flowers possess radial symmetry, allowing them to be divided into two similar halves by any radial plane passing through the center. Common examples include Datura, mustard, and chili. In contrast, zygomorphic flowers like Cassia, Pisum, and Sesbania exhibit bilateral symmetry and can only be divided into two equal halves along a single vertical plane. This distinction is fundamental in taxonomy.

13. (1) A-IV, B-II, C-I, D-III
Monoadelphous stamens are united into a single bundle, a feature seen in China rose. Diadelphous stamens are arranged in two bundles, typical of the pea family. Polyadelphous stamens are grouped into more than two bundles, as observed in Citrus. Epiphyllous stamens occur when they are attached to the perianth, which is a common characteristic found in members of the lily family.

14. (3) (A) Perigynous; (B) Epigynous
In perigynous flowers, the gynoecium is situated in the center and other parts of the flower are located on the rim of the thalamus almost at the same level. In epigynous flowers, the margin of the thalamus grows upward enclosing the ovary completely and getting fused with it, while other floral parts arise above the ovary. These arrangements determine ovary position.

15. (1) A-II, B-IV, C-I, D-III
Rose flowers are perigynous with a half-inferior ovary. Pea plants exhibit marginal placentation where the placenta forms a ridge along the ventral suture of the ovary. Cotton flowers show twisted aestivation where one margin of a petal overlaps the next one. Mango produces a drupe, which is a fleshy fruit with a stony endocarp. These features identify their respective families.

16. (4) A and C only
Sesbania and Indigofera belong to the Fabaceae family, which is characterized by a monocarpellary, unilocular ovary containing many ovules. This ovary develops into a legume fruit. In contrast, Brinjal and Tobacco belong to Solanaceae, which features a bicarpellary, syncarpous ovary. Asparagus is a member of the Liliaceae family, characterized by a tricarpellary, syncarpous ovary with axile placentation and multiple ovules.

17. (3) Both (A) and (R) are true and (R) is the correct explanation of (A).
A flower is botanically defined as a modified shoot where the shoot apical meristem transforms into a floral meristem. During this transformation, the internodes of the shoot do not elongate and the axis becomes condensed. Consequently, the apex produces different types of floral appendages laterally at successive nodes instead of leaves. This structural condensation confirms that a flower is a modified shoot.

18. (1) valvate
In Calotropis, the sepals or petals in a whorl just touch one another at the margin without any overlapping. This specific arrangement is known as valvate aestivation. It is distinguished from twisted aestivation where margins overlap regularly, or imbricate aestivation where overlapping occurs without a specific direction. Valvate aestivation is a key diagnostic feature for identifying various species within specific families.

19. (4) Standard, Wings and Keel
The papilionaceous corolla of a pea flower consists of five petals with a specific vexillary aestivation pattern. The largest posterior petal is called the standard or vexillum. It overlaps two lateral petals known as wings. These wings, in turn, overlap the two smallest anterior petals, which are fused together to form a boat-shaped structure called the keel or carina.

20. (4) (A)-(III), (B)-(I), (C)-(II), (D)-(IV)
Zygomorphic symmetry is found in Cassia, where the flower can be split into two equal halves in only one plane. Mustard has a hypogynous flower with a superior ovary. Plum is an example of a perigynous flower where the ovary is half-inferior. Cucumber features an epigynous flower where the thalamus encloses the ovary completely, resulting in an inferior ovary.

21. (2) China rose, Petunia and lemon
Axile placentation occurs when the placenta is axial and the ovules are attached to it in a multilocular ovary. This arrangement is common in China rose, Petunia, and lemon. In these plants, the ovary is divided into multiple chambers by septa, and the ovules arise from the central axis. This type of placentation is distinct from marginal, parietal, and basal types.

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22. (3) Diadelphous and dithecous anthers
Family Fabaceae is uniquely characterized by diadelphous stamens, where ten stamens are typically arranged in two bundles, often nine fused and one free. These stamens also possess dithecous anthers, meaning each anther has two lobes. While Solanaceae has epipetalous stamens and Liliaceae has epiphyllous stamens, the diadelphous arrangement is a specific diagnostic feature that distinguishes the Fabaceae family from others.

23. (3) (B), (C), (D) and (E) only
Axillary buds in cucumber form spiral tendrils for climbing. Opuntia features flattened, fleshy stems for photosynthesis. Rhizophora possesses pneumatophores that grow upward for oxygen absorption in marshy areas. Grasses and strawberries use subaerial stems for vegetative propagation. However, thorns in Citrus and Bougainvillea are modified axillary buds, not modified leaflets, making the first statement incorrect while all other descriptions are accurate.

24. (2) (B), (C) only
Zygomorphic flowers, such as Gulmohar and Cassia, exhibit bilateral symmetry and can be divided into identical halves only along a single vertical plane. These are common in the Fabaceae family. Conversely, mustard, Datura, and chilly show actinomorphic symmetry, meaning they possess radial symmetry and can be divided into two equal halves through any radial plane passing through the center of the flower.

25. (2) Pisum sativum
Pisum sativum, commonly known as the pea plant, belongs to the Fabaceae family. It is characterized by vexillary aestivation in its corolla and diadelphous stamens in its androecium. In this arrangement, ten stamens are organized into two bundles, typically nine fused and one free. These specific morphological traits are diagnostic for the Papilionoideae subfamily, distinguishing it from Solanaceae or Liliaceae families.

26. (4) pea
Diadelphous stamens are a condition where the filaments of the stamens are fused into two separate bundles. This is a characteristic feature of the pea plant and other members of the Fabaceae family. In contrast, China rose exhibits a monadelphous condition with stamens fused into a single tube, while citrus plants often show a polyadelphous condition where stamens are united into several bundles.

27. (2) (iii) (iv) (ii) (i)
The formula with zygomorphic symmetry and diadelphous stamens corresponds to Fabaceae. The formula showing actinomorphic symmetry and epipetalous stamens represents Solanaceae. The formula with a perianth and tricarpellary ovary is characteristic of Liliaceae. Finally, the formula with four petals arranged in a cross and tetradynamous stamens represents the Brassicaceae family. These formulas provide a concise summary of essential floral characteristics.

28. (1) fibrous roots
In monocotyledonous plants, the primary root is often short-lived and is soon replaced by a large number of roots. These roots originate from the base of the stem and constitute the fibrous root system. This is commonly observed in the wheat plant. In contrast, primary roots develop from the radicle, while prop roots are adventitious roots providing mechanical support to heavy branches.

29. (1) inferior ovary
Ray florets are the peripheral flowers found in the composite inflorescence of the Asteraceae family, such as in sunflowers. These florets are characterized by having an epigynous condition where the floral parts are situated above the ovary. Consequently, the ovary in ray florets is described as inferior. This arrangement contrasts with disc florets and other flowers where the ovary might be superior.

30. (4) plum
A half inferior ovary is found in perigynous flowers where the gynoecium is situated in the center and other floral parts are located on the rim of the thalamus at approximately the same level. This condition is characteristic of plants like plum, rose, and peach. Brinjal and mustard have superior ovaries, while sunflowers possess inferior ovaries. Understanding these positions is vital.

31. (1) hilum
The hilum represents the junction where the body of the ovule fuses with the funicle, which is the stalk attaching the ovule to the placenta. It serves as a point of attachment and remains visible as a scar on the seed coat after the seed

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matures. Other parts like the micropyle, nucellus, and chalaza represent different structural regions and openings within the ovule.

32. (4) parietal
In parietal placentation, the ovules develop on the inner wall of the ovary or on the peripheral part. The ovary is typically one-chambered, but it may appear two-chambered due to the formation of a false septum, known as a replum, in some cases. Common examples of this type of placentation include mustard and Argemone. This arrangement is distinct from axile or basal.

33. (3) (A)-(iv), (B)-(ii), (C)-(i), (D)-(iii)
Basal placentation occurs in sunflowers where a single ovule is attached to the base of the ovary. China rose exhibits axile placentation with ovules on a central axis in a multilocular ovary. Parietal placentation is found in mustard as ovules develop on the inner wall. Dianthus shows free central placentation, where ovules are borne on a central axis that is not connected.

34. (2) adventitious root
Sweet potato is a modification of adventitious roots that become swollen due to the storage of food. Unlike the common potato, which is a modified underground stem called a tuber, the sweet potato specifically involves the transformation of roots that arise from parts of the plant other than the radicle. This distinction between stem and root modifications is a fundamental morphological concept.

35. (2) stem
In Bougainvillea, the thorns are modifications of the stem, specifically arising from axillary buds. These hard, woody, and pointed structures serve a protective function against browsing animals. Stem modifications like thorns are distinct from leaf modifications or adventitious roots. Identifying whether a structure like a thorn originates from a bud or a leaf is crucial for understanding the morphological adaptations of plants.

36. (4) drupe
The fruit of the coconut is classified as a drupe. Drupes are fleshy fruits characterized by a stony endocarp that encloses the seed. In a coconut, the fruit develops from a monocarpellary superior ovary. It features a thin epicarp, a fibrous mesocarp, and a hard, stony endocarp. This structure is also seen in mangoes, although the mesocarp in mangoes is fleshy.

37. (2) endosperm
The edible portion of the coconut is the endosperm, which provides nourishment for the developing embryo. In a mature coconut, this consists of the white kernel and the liquid coconut water. The coconut water is specifically the free-nuclear endosperm, while the surrounding white kernel represents the cellular endosperm. This makes the coconut unique, as the primary nutritious part is the food storage tissue.

38. (3) Pitcher of Nepenthes
The pitcher of Nepenthes, or the pitcher plant, is a specialized modification of the leaf designed to capture and digest insects. In contrast, the tendrils of cucumber and thorns of citrus are modifications of the stem, specifically arising from axillary buds. The flattened green structures of Opuntia, known as phylloclades, are also stem modifications adapted for photosynthesis and water conservation in arid environments.

39. (1) phylloclades
Phylloclades are modified stems that become flattened and green to perform photosynthesis, effectively taking over the function of leaves. These structures are common in xerophytic plants like Opuntia, where leaves are reduced to spines to minimize water loss. Phylloclades can have many internodes and are capable of unlimited growth. This adaptation allows plants to survive and thrive in arid environments.

40. (2) androecium
The term polyadelphous refers to a specific condition of the androecium where the stamens are united into more than two bundles or groups. This is a common characteristic in plants like Citrus. It is part of the classification of stamens based on their fusion patterns, which also includes monadelphous and diadelphous arrangements. These variations in stamen fusion are important diagnostic features.

41. (4) Six
Among the listed plants, Salvia, mustard, radish, and turnip have stamens of different lengths within the same flower. Salvia exhibits stamens with unequal filaments, while mustard, radish, and turnip belong to the Brassicaceae family, which typically features tetradynamous stamens

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where four are long and two are short. Other plants listed, such as Indigofera, Sesbania, and gram, belong to Fabaceae. Therefore, exactly four plants show this.

42. (1) Brassica
Radial symmetry, also known as actinomorphic symmetry, allows a flower to be divided into two equal halves through any vertical plane passing through the center. Brassica, a member of the mustard family, exhibits this type of symmetry. In contrast, Trifolium, Pisum, and Cassia exhibit zygomorphic symmetry, where the flower can only be divided into two identical halves along one specific vertical plane.

43. (1) Dianthus
Free central placentation is characterized by ovules being borne on a central axis while the partitions or septa are absent within the ovary. This specific arrangement is found in flowers of Dianthus and Primrose. In other types, such as Argemone and Brassica, the placentation is parietal. Citrus exhibits axile placentation where ovules are attached to a central axis in a multilocular ovary.

44. (1) vexillum
In a papilionaceous corolla, which is characteristic of the Fabaceae family, the five petals are arranged in a specific pattern. The largest, posterior petal is technically called the vexillum or the standard. It overlaps two smaller lateral petals called wings or alae, which in turn overlap the two smallest anterior petals known as the keel or carina. This arrangement defines vexillary aestivation.

45. (2) scutellum
In monocotyledonous seeds like maize, the embryo contains only one large and shield-shaped cotyledon known as the scutellum. It is situated towards one side of the endosperm. The scutellum plays a vital role in absorbing nutrients from the endosperm and transferring them to the growing embryo during germination. Other structures like the coleoptile and coleorhiza serve as protective sheaths for embryonic parts.

46. (3) Liliaceae
A tricarpellary, syncarpous gynoecium, where the ovary is three-chambered with axile placentation, is a characteristic feature of the Liliaceae family. This family consists of monocotyledonous plants like lilies, tulips, and onions. In contrast, Fabaceae has a monocarpellary gynoecium, Solanaceae has a bicarpellary gynoecium, and Poaceae typically has a reduced gynoecium with a single ovule and basal placentation. These distinctions identify families.

47. (4) Pistia
Pistia is a free-floating aquatic plant where the entire plant surface is in contact with water. In such hydrophytes, the root system is poorly developed, and its primary function is often balance rather than water absorption. Consequently, the roots play an insignificant role in absorbing water, as the plant can absorb moisture directly through its leaves and stems. Terrestrial plants rely on roots.

48. (3) Opuntia
In xerophytic plants like Opuntia, the leaves are modified into sharp spines to reduce the surface area for transpiration and to protect the plant from herbivores. The stem becomes flattened, green, and fleshy to perform photosynthesis, a structure called a phylloclade. This is different from the leaf tendrils of pea or the succulent leaves of onion. Silk cotton has compound leaves.

49. (4) Six
Out of the eight plants listed, China rose, mustard, brinjal, potato, onion, and tulip possess a superior ovary. These plants are described as hypogynous because the floral parts are situated below the ovary. In contrast, guava and cucumber are epigynous, meaning they have an inferior ovary where the floral parts are located above it. Understanding these floral arrangements is essential for classification.

50. (4) lemon
Axile placentation is found in multilocular ovaries where the ovules are attached to a central axis formed by the fusion of the margins of the carpels. This type is typical of lemon, China rose, and tomato. In contrast, pea shows marginal placentation, Argemone exhibits parietal placentation, and Dianthus features free central placentation. These distinct patterns are vital morphological characteristics used in taxonomy.

51. (4) Indigofera
The keel is a distinctive feature of the papilionaceous corolla found in the Fabaceae

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family. It consists of the two smallest, anterior petals that are fused together to form a boat-like structure. Indigofera belongs to this family and thus exhibits this trait. Other plants like Aloe and tulip belong to Liliaceae, while tomato belongs to Solanaceae. These families do not possess the keel structure.

52. (1) scutellum
In cereal grains like wheat and maize, the embryo is located at one end of the endosperm. It consists of a single, large, shield-shaped cotyledon called the scutellum. The scutellum is responsible for nutrient absorption during germination. The embryonic axis is enclosed by protective sheaths: the coleoptile covering the plumule and the coleorhiza covering the radicle. This structure is unique to monocots.

53. (1) Petunia
The floral formula provided represents a flower that is actinomorphic, bisexual, with five fused sepals, five fused petals, five epipetalous stamens, and a bicarpellary syncarpous superior ovary. This set of characteristics is typical of the Solanaceae family. Petunia is a well-known member of this family. In contrast, Brassica belongs to Brassicaceae, Allium to Liliaceae, and Sesbania to the Fabaceae family.

54. (4) potato
Potato is a classic example of an edible underground stem modification known as a tuber. It stores starch and possesses eyes, which are axillary buds capable of vegetative reproduction. In contrast, carrots and sweet potatoes are modified roots that store food. Groundnuts produce fruits underground but are not themselves modified stems. Identifying the morphological origin of storage organs is a key botanical concept.

55. (2) imbricate
Imbricate aestivation occurs when the margins of sepals or petals overlap one another, but the overlapping does not follow a specific or regular direction. This is commonly seen in flowers like Cassia and Gulmohar. It differs from twisted aestivation, where one margin overlaps the next in a consistent direction, and vexillary aestivation, which involves a specific large posterior petal overlapping lateral petals.

56. (3) tomato
In a tomato fruit, which is a berry, both the fruit wall known as the pericarp and the internal tissue known as the placenta are edible. The fruit develops from a multicarpellary, syncarpous ovary. In contrast, the edible part of an apple is the fleshy thalamus, making it a false fruit. For a banana, the edible parts are the mesocarp and endocarp.

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57. (2) multicarpellary apocarpous gynoecium
An aggregate fruit develops from a single flower that has a multicarpellary, apocarpous gynoecium. In this condition, several carpels are present but remain free from one another. Each individual carpel develops into a small fruitlet, and the entire collection forms a single aggregate fruit. Common examples include strawberries and raspberries. This differs from simple fruits, which develop from single fused ovaries.

58. (3) A proteinaceous aleurone layer is present in maize grain
In maize, which is a monocotyledonous cereal, a specialized protein-rich layer called the aleurone layer surrounds the endosperm and separates it from the embryo. Most monocot seeds, including grasses, are endospermic. Mango is a drupe developed after fertilization, not a parthenocarpic fruit. A sterile stamen is called a staminode, while a sterile pistil is known as a pistillode. Maize provides this correct description.

59. (1) Three
Opposite phyllotaxy occurs when a pair of leaves arises at each node and lies opposite to each other. Among the listed plants, Ocimum, guava, and Calotropis exhibit this arrangement. China rose, mustard, and sunflower have alternate phyllotaxy, where a single leaf arises at each node. Alstonia and Nerium show whorled phyllotaxy, characterized by more than two leaves per node. Exactly three plants show this.

60. (4) soybean
Racemose inflorescence is characterized by the main axis continuing to grow indefinitely, with flowers borne laterally in an acropetal succession. Soybean, a member of the Fabaceae family, typically exhibits this type of inflorescence. In contrast, tulip and Aloe show cymose inflorescence, where the main axis terminates in a flower and growth is limited. Brinjal also shows a cymose or solitary arrangement.

61. (4) terminates in a flower
In a cymose inflorescence, the growth of the main axis is limited because it terminates in a flower. Consequently, the flowers are arranged in a basipetal order, meaning the oldest flower is at the apex and younger flowers are produced lower down on the axis. This contrasts with racemose inflorescence, where the main axis has unlimited growth and flowers are borne laterally.

62. (1) Fifteen
Hypogynous flowers have a superior ovary with other floral parts situated below it. From the list, mustard, brinjal, china rose, lupin, sunhemp, gram, bean, chilli, Petunia, tomato, Withania, potato, onion, Aloe, and tulip possess this arrangement, totaling fifteen plants. Pumpkin, bitter gourd, and cucumber are epigynous with inferior ovaries. Guava is also epigynous. Plum and rose are perigynous with half-inferior ovaries.

63. (3) actinomorphic, hypogynous with twisted aestivation
China rose (Hibiscus rosa-sinensis) produces flowers that exhibit actinomorphic or radial symmetry. The flowers are hypogynous, meaning the ovary is superior and other floral parts are located below it. Furthermore, the petals show twisted aestivation, where the margin of one petal regularly overlaps the next. These diagnostic features are essential for identifying members of the Malvaceae family and distinguishing them from others.

64. (2) Seven
Valvate aestivation is characterized by sepals or petals in a whorl just touching one another at the margin without overlapping. From the list, Calotropis, tulip, Asparagus, Colchicum, Petunia, tobacco, and mustard exhibit this pattern in their flowers, making a total of seven. Members of the Fabaceae family listed, such as Sesbania and Indigofera, typically show vexillary aestivation in their specialized corolla arrangement.

65. (3) Australian Acacia
A phyllode is a specialized modification where the petiole or part of the leaf rachis becomes flattened, green, and leaf-like to perform photosynthesis. This adaptation is seen in Australian Acacia, where the normal leaflets are short-lived and fall off early. In contrast, phylloclades are modified stems seen in Opuntia and Euphorbia, while cladodes are modified stems seen in Asparagus.

66. (1) Solanum
In a cymose inflorescence, the main axis terminates in a flower, which limits its growth. Solanum, a genus in the Solanaceae family, typically exhibits this type of floral arrangement. In contrast, Sesbania, Trifolium, and Brassica show racemose inflorescences, where the main axis continues to grow and flowers are produced in an acropetal succession. These types of inflorescence are fundamental diagnostic features.

67. (4) axile
Axile placentation is found in tomato and lemon, where the ovules are attached to a central axis in a multilocular ovary. In this arrangement, the ovary is divided into two or more chambers by septa, and the placenta is located at the center where these septa meet. This is distinct from parietal placentation where ovules are on the wall.

68. (4) Michelia
In flowers like Michelia, the gynoecium is apocarpous, meaning it consists of many carpels that remain free from each other. This is a primitive characteristic. In contrast, Papaver, tomato, and Aloe exhibit a syncarpous condition where the carpels are fused together. Identifying whether carpels are free or fused is a critical diagnostic feature used in the botanical classification of various angiosperms.

69. (3) Six
Marginal placentation is a characteristic of the Fabaceae family, where the placenta forms a ridge along the ventral suture of the ovary. Among the plants listed, Gram, Arhar, Sun-hemp, Moong, Pea, and Lupin belong to this family and exhibit this type of placentation, making a total of six. Mustard shows parietal placentation, while members of Solanaceae and Liliaceae typically show axile placentation.

70. (3) Three
Composite fruits, also known as multiple fruits, develop from an entire inflorescence rather than a single flower. In the provided list, fig, pineapple, and mulberry are examples of composite fruits. Fig develops from a hypanthodium inflorescence, while pineapple and mulberry develop from spadix and catkin inflorescences, respectively.

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Other fruits mentioned, like poppy and tomato, are simple fruits developed from single flowers.

71. (1) endosperm
The edible portion of a coconut consists entirely of endosperm tissue. The liquid coconut water is specifically free-nuclear endosperm, containing numerous nuclei. As the fruit matures, these nuclei are used to form cells, resulting in the solid white kernel known as cellular endosperm. Therefore, both the liquid and the solid edible parts are equivalent to the primary food storage tissue of seeds.

72. (1) Fabaceae
Vexillary aestivation is a unique and characteristic arrangement of petals found in the Fabaceae family. It involves five petals where the largest posterior one overlaps two lateral petals, which in turn overlap two smaller fused anterior petals. This specific floral architecture is also referred to as papilionaceous. It is a key diagnostic feature that distinguishes members of the pea and bean family.

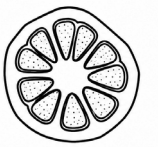
73. (4) turnip
Sweet potato and turnip are homologous structures because both are modified roots specialized for the storage of food. Specifically, the sweet potato is a modified adventitious root, while the turnip is a modified taproot. In contrast, potato, ginger, and Colocasia are all modified underground stems. Homology refers to structures that share a similar evolutionary origin even if they serve the same function.

74. (4) Alstonia
Alstonia exhibits a whorled phyllotaxy, where more than two leaves arise at each node and form a circle or whorl. These leaves are simple and show reticulate venation, a common characteristic of dicotyledonous plants. In contrast, Calotropis has opposite phyllotaxy, and China rose shows alternate phyllotaxy. Neem has pinnately compound leaves. Thus, Alstonia fits the description of whorled simple leaves.

75. (2) gulmohar
Zygomorphic flowers, such as gulmohar, exhibit bilateral symmetry, meaning they can be divided into two equal halves only by a single vertical plane. This is common in many members of the Fabaceae and Caesalpiniaceae families. In contrast, mustard, tomato, and Datura are examples of actinomorphic flowers. These flowers have radial symmetry and can be divided by any radial plane through the axis.

76. (1) peach
Peach possesses a half inferior ovary, which is typical of perigynous flowers. In this arrangement, the gynoecium is located in the center, and the other floral parts are attached to the rim of a cup-shaped thalamus at roughly the same level as the ovary. Other examples include plum and rose. Cucumber and guava have inferior ovaries, while cotton has a superior ovary.

77. (1)



Dianthus exhibits free central placentation, where the ovules are borne on a central axis and the ovary is unilocular because the septa are absent. In this type, the placenta arises from the base of the ovary and extends into the cavity without being attached to the walls by any partitions. This arrangement is visually represented by a central column of ovules.

78. (1) mango
A drupe is a type of fleshy fruit that typically develops from a monocarpellary superior ovary and contains a single seed. It is characterized by having a stony endocarp. Mango is a classic example where the fruit consists of an outer thin epicarp, a middle fleshy edible mesocarp, and an inner hard stony endocarp. Wheat is a caryopsis, while pea is a legume.

79. (4) Flower of tulip is a modified shoot
A flower is botanically considered a modified shoot where the shoot apical meristem becomes a floral meristem. Tulip follows this fundamental principle. Regarding other choices, the tomato fruit is a berry, not a capsule. Orchid seeds are generally non-endospermic and very small. Placentation in primrose is free central rather than basal. Therefore, the statement regarding the flower being a modified shoot is accurate.

80. (2) $\oplus\ \male\!\female\ K_{(5)}\ C_{(5)}\ A_5\ \underline{G}_{(2)}$
Chilli belongs to the Solanaceae family, which is characterized by actinomorphic, bisexual flowers. The calyx consists of five fused sepals, and the corolla has five fused petals. There are

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five stamens that are epipetalous, meaning they are attached to the petals. The gynoecium is bicarpellary, syncarpous with a superior ovary. These features are accurately summarized in the chosen floral formula symbols.

81. (1) Opuntia
Opuntia is a xerophytic plant that has adapted to arid conditions by modifying its stem into a flat, green, and succulent structure called a phylloclade. This modified stem contains chlorophyll and performs photosynthesis, effectively replacing the leaves, which are reduced to spines to minimize water loss through transpiration. This adaptation allows the plant to store water and survive in harsh environments.

82. (2) basal
Basal placentation occurs when the placenta is located at the base of the ovary and a single ovule is attached to it. The ovary is typically unilocular. This type is common in families like Asteraceae and Poaceae, with examples including sunflowers and marigolds. This arrangement is distinct from marginal placentation where ovules are along a suture, or free central and axile types.

83. (4) bean
The keel is a specialized structure consisting of two fused anterior petals, which is a characteristic feature of the papilionaceous flowers found in the Fabaceae family. Bean plants belong to this family and therefore possess a keel. Other components of this floral arrangement include the large posterior standard petal and two lateral wing petals. Calotropis has valvate aestivation and lacks this arrangement.

84. (2) plum
In plum, the flower is perigynous, meaning the thalamus forms a cup-like structure where the gynoecium is located in the center and other floral parts arise from the rim. This results in the ovary being half inferior. This condition is also found in rose and peach. In contrast, guava and cucumber have inferior ovaries, while brinjal has a superior ovary in hypogynous flowers.

85. (1) monadelphous
In China rose (Hibiscus rosa-sinensis), the stamens are fused by their filaments into a single bundle or tube that surrounds the style. This condition is known as monadelphous. This is a characteristic feature of the Malvaceae family. In contrast, diadelphous means fusion into two bundles, and polyadelphous means fusion into several bundles. Monadelphous is the precise term for this arrangement.

86. (1)

Cotton flowers exhibit twisted aestivation in their petals. In this arrangement, the margin of one petal overlaps that of the next one in a regular, sequential manner. This creates a specific visual pattern where each petal has one edge tucked under and the other edge overlapping the adjacent petal. This characteristic overlapping is a key diagnostic feature for the Malvaceae family.

87. (1) Cotyledon
The scutellum is the specialized, shield-shaped structure found in the seeds of cereals like wheat and maize. It is morphologically equivalent to the cotyledon of other monocotyledonous plants. While dicotyledons usually have two cotyledons that store food, monocots have a single cotyledon. In grasses, this single cotyledon has evolved into the scutellum, which functions primarily in absorbing nutrients from endosperm.

88. (3) $\% \, ♂ ♀ \, K_{(5)} \, C_{1+2+(2)} \, A_{(9)+1} \, \underline{G}_{1}$
Soybean belongs to the Fabaceae family, which features zygomorphic, bisexual flowers. The calyx has five fused sepals. The corolla shows vexillary aestivation with one standard, two wings, and two fused keel petals. The androecium is diadelphous, with ten stamens arranged in two bundles of nine fused and one free. The gynoecium is monocarpellary with a superior ovary. These characters identify soybean.

89. (2) (i) and (ii)
Statement (i) correctly describes vexillary aestivation with its characteristic standard, wings, and keel petals. Statement (ii) accurately provides the floral formula for the Liliaceae family, including the perianth and tricarpellary ovary. Statement (iii) is incorrect because pea stamens are diadelphous, not monadelphous. Statement (iv) is incorrect because the Solanaceae floral formula typically has five sepals, petals, and stamens, not smaller numbers.

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90. (2) lemon
Axile placentation occurs when ovules are attached to a central axis in a multilocular ovary, which is formed by the fusion of multiple carpels. Lemon is a classic example of this arrangement. In contrast, Dianthus shows free central placentation, marigold shows basal placentation, and Argemone shows parietal placentation. Identifying these placentation types is essential for the taxonomic study of various flowering plants.

91. (2) syconus
A syconus is a type of composite fruit that develops from a hypanthodium inflorescence. In this arrangement, the fleshy receptacle forms a hollow cavity with an apical opening, and the flowers are borne on the inner wall. This is characteristic of the genus Ficus, which includes figs. In contrast, sorosis develops from a spike or spadix inflorescence, while caryopsis are types of simple fruits.

92. (4) groundnut and pomegranate
In groundnut, the edible parts are the cotyledons, which store protein and oil. In pomegranate, the edible portion is the juicy, fleshy testa, which is the outer layer of the seed coat. While litchi has an edible aril and coconut has an edible endosperm, the combination of cotyledons and testa specifically refers to groundnut and pomegranate respectively among the provided options.

93. (3) castor
Castor seeds are characterized by the presence of specific structures: the endosperm, which provides nutrition, and a caruncle, which is a fleshy outgrowth near the micropyle. While perisperm is persistent nucellus (found in seeds like black pepper and beet), castor is the primary example of an endospermic dicot seed with a caruncle. This combination of features is a distinctive diagnostic characteristic of the castor bean plant, Ricinus communis.

94. (3) tobacco
The floral formula provided indicates an actinomorphic, bisexual flower with five fused sepals, five fused petals, five epipetalous stamens, and a bicarpellary syncarpous superior ovary. This description perfectly matches the characteristics of the Solanaceae family. Among the options, tobacco is a prominent member of this family. Soybean and sunhemp belong to Fabaceae, while tulip belongs to Liliaceae, having different structures.

95. (4) mustard
A replum is a false septum that develops in the ovary of certain plants, making a unilocular ovary appear bilocular. This feature is characteristic of the Brassicaceae family, which includes mustard. The ovules are attached to the parietal placenta. This differs from the marginal placentation in peas, the axile placentation in lemons, and the basal placentation found in sunflowers during classification.

96. (3) achenes
In the syconus fruit of a fig, the fleshy receptacle becomes succulent and encloses many small, individual fruits. Each of these tiny fruits is technically an achene, which developed from the female flowers located inside the hypanthodium inflorescence. This unique structure makes the fig a composite fruit. The combination of the edible, fleshy receptacle and the numerous small achenes provides the characteristic texture.

97. (4) cypsela
A cypsela is a dry, indehiscent, single-seeded fruit that develops from a bicarpellary, syncarpous, inferior ovary. It is a characteristic feature of the Asteraceae family, such as sunflowers and marigolds. Often, it is accompanied by a persistent calyx modified into hair-like structures called pappus, which aids in wind dispersal. This distinguishes it from caryopsis, where the seed coat is fused with pericarp.

98. (3) pomegranate
The pomegranate fruit is a specialized type of berry known as a balausta. It develops from a multicarpellary, syncarpous, inferior ovary. The fruit is divided into several chambers by leathery septa. The edible parts are the individual seeds, specifically their juicy and succulent outer seed coat, known as the testa. This unique combination of an inferior ovary and succulent testa defines pomegranate.

99. (1) pea
In non-endospermic or exalbuminous seeds like pea, the endosperm is completely consumed by the developing embryo during seed maturation. Consequently, food is stored in the cotyledons instead. In contrast, maize, coconut, and

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castor represent endospermic seeds where the endosperm persists in the mature seed and serves as a nutrient source for the embryo. This distinction is fundamental to seed development studies.

100. (3) styles
The long, silky, filamentous threads that protrude from the end of a young cob of maize are the styles and stigmas of the female flowers. Their primary function is to trap wind-borne pollen grains for fertilization. Each thread is attached to an individual ovary on the cob. These elongated structures are an adaptation for wind pollination in the corn plant.

101. (4) a cluster of compactly borne flowers on a common axis
The pineapple is a composite or multiple fruit known as a sorosis. It develops from a whole inflorescence, specifically a spike or spadix, where a cluster of flowers is compactly borne on a common fleshy axis. After fertilization, the individual fruits, their bracts, and the central axis all fuse together to form a single, large, succulent structure for seed dispersal.

102. (1) Litchi
In litchi, the edible portion is the aril, which is a fleshy, succulent outgrowth from the funicle or the base of the ovule that grows to surround the seed. While the pericarp forms the outer leathery skin and is not eaten, the juicy white aril provides the sweet part commonly consumed. This is distinct from other fruits like pomegranate or orange.

103. (4) Solanaceae
The Solanaceae family is characterized by flowers that are typically pentamerous and actinomorphic. A key diagnostic feature is the bicarpellary, syncarpous gynoecium where the ovary is placed obliquely in the flower and the placenta is swollen with many ovules. The fruit produced is usually a berry or a capsule. These specific features distinguish Solanaceae from Liliaceae, Asteraceae, and Brassicaceae families.

104. (4) Juicy aril
Litchi is unique among common fruits because the part consumed is neither the pericarp nor the thalamus. Instead, it is the juicy aril, an accessory tissue that develops from the funicle of the seed and eventually envelops it. The outer rough skin is the pericarp. This specialized development is a characteristic feature of the litchi fruit, distinguishing it from common drupes.

105. (4) mesocarp
Mango is a drupe, which is a fleshy fruit with a stony endocarp. The fruit wall, or pericarp, is differentiated into three layers: the outer thin epicarp, the middle fleshy edible mesocarp, and the inner hard stony endocarp. Humans consume the succulent, sweet, and fibrous mesocarp. The endocarp is the hard pit that protects the single seed located inside.

106. (3) endocarp
In citrus fruits like lemon and orange, the fruit is a specialized berry called a hesperidium. The fruit wall is divided into three layers. The outer leathery skin is the epicarp, the middle white fibrous part is the mesocarp, and the inner layer is the endocarp. The juicy hair-like structures that we eat actually develop from the inner lining of endocarp.

107. (1) proteins
The aleurone layer is a specialized outermost layer of the endosperm found in cereal grains like maize. It is biologically significant because it is exceptionally rich in proteins. During seed germination, the aleurone layer secretes various enzymes, such as amylase, which break down the stored starch in the endosperm into simpler sugars to nourish the growing embryo during the maturation process.

108. (2) peanut
A geocarpic fruit is one that develops and matures underground. The peanut is a well-known example. After fertilization occurs in the aerial flowers, the flower stalks elongate and push the developing ovaries into the soil, where the pods eventually mature. This unique reproductive strategy protects the developing seeds from predators. In contrast, potato is a stem modification, not a fruit.

109. (1) mesocarp
The mango fruit, technically a drupe, is characterized by its three-layered pericarp. The outer skin is the epicarp, the innermost hard layer surrounding the seed is the endocarp, and the middle portion is the mesocarp. In the case of mango, this mesocarp is thick, fleshy, and

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succulent, making it the primary edible portion of the fruit consumed by humans and animals.

110. (1) Axillary bud
The eyes found on a potato tuber are actually nodes that contain axillary buds. Since the potato is a modified underground stem used for food storage, it retains these characteristic stem features. These buds are capable of developing into new shoots, allowing for vegetative propagation. This is why a piece of potato containing at least one eye can grow a new plant.

111. (4) Date palm-mesocarp
In the date palm fruit, the edible portion is the fleshy mesocarp. For other options: the edible part of a tomato is both the pericarp and placenta; in maize, it is the entire grain including the endosperm and embryo; and in guava, both the thalamus and the pericarp are edible. Therefore, the pairing of date palm with its mesocarp is accurate.

112. (2) mesocarp and less developed endocarp
The banana is a fleshy fruit where the outer skin or epicarp is typically peeled away. The edible portion inside consists of the thick, fleshy mesocarp and the inner, less developed endocarp. Since cultivated bananas are often parthenocarpic, they do not contain functional seeds, and the central part representing the endocarp remains soft and palatable along with the sweet mesocarp tissue.

113. (4) brinjal
A bicarpellary, syncarpous gynoecium with an obliquely placed ovary is a distinctive diagnostic feature of the Solanaceae family. Brinjal belongs to this family and exhibits this characteristic arrangement. In contrast, Pisum is monocarpellary and banana is tricarpellary. While mustard is bicarpellary like brinjal, it lacks the oblique ovary and swollen placenta characteristic of Solanaceae.

114. (1) Cruciferae
The tetradynamous condition is a specific arrangement of the androecium where there are six stamens in total. Four inner stamens have long filaments, while the two outer stamens have shorter filaments. This configuration is a characteristic feature of the Cruciferae family, also known as Brassicaceae, which includes plants like mustard. This arrangement is distinct from the monadelphous condition in Malvaceae.

115. (1) the vegetation which is found in marshy and saline lake
Pneumatophores are specialized respiratory roots found in plants growing in marshy, saline, and oxygen-poor environments, such as mangroves. These roots grow vertically upward from the soil into the air, allowing the plant to obtain oxygen for respiration that is otherwise unavailable in waterlogged mud. This adaptation is essential for the survival of halophytes like Rhizophora in their natural salty habitats.

116. (1) style
The long, hair-like structures emerging from the tip of a corn cob are the styles and stigmas of the female flowers. Their elongated nature serves to capture pollen grains carried by the wind. Each individual silk is a style that leads to a single ovary, which will eventually become a kernel of corn after successful fertilization. This morphological adaptation is reproductive.

117. (3) groundnut
Groundnut produces geocarpic fruits. After the aerial flowers are fertilized, the stalk at the base of the ovary elongates into a peg that grows downward, pushing the ovary into the soil. The fruit then develops and matures entirely underground. This strategy protects the seeds from heat and predators. While carrots and radishes are underground, they are modified roots rather than fruits.

118. (2) Malvaceae - cotton
Cotton is a well-known member of the Malvaceae family, sharing characteristics like monadelphous stamens and twisted aestivation. For other pairings: Brassicaceae includes mustard, while sunflower belongs to Asteraceae; Papilionaceae includes pulses, while Catechu belongs to the Mimosoideae group; Liliaceae includes lilies and onions, while wheat belongs to Poaceae. Thus, the pairing of Malvaceae with cotton is the only accurate match.

119. (4) orchid
Clinging roots are a type of adventitious root found in many epiphytic orchids. These roots help the plant attach itself firmly to the bark of trees or other supports. Unlike parasitic roots, they do not penetrate the host tissue to absorb nutrients

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but merely provide mechanical anchorage. Some orchids also have specialized aerial roots to absorb moisture from the atmosphere around them.

120. (1) total root parasite
The largest flowers in the world belong to the genus Rafflesia. These plants are total root parasites, meaning they lack chlorophyll and leaves, relying entirely on a host vine for nutrients and water. The plant body exists primarily as a network of filaments within the host's tissue, and it only becomes visible when it produces its massive, ground-level flower for reproduction.

121. (2) reproductive parts are more stable and conservative than vegetative parts
Floral features are primarily used for identifying angiosperms because reproductive parts, such as flowers and fruits, are more evolutionarily stable and less affected by environmental changes than vegetative parts like leaves and stems. Vegetative characters can vary significantly based on light or soil conditions. Reproductive structures maintain consistent patterns of symmetry and organization, providing reliable diagnostic traits for plant taxonomic classification.

122. (4) Pomegranate
Pomegranate would lose its economic value if produced by parthenocarpy because its edible part is the succulent seed coat, or testa. Parthenocarpy produces seedless fruits, and without seeds, there would be no edible portion in a pomegranate. In contrast, fruits like orange and banana are valued for their fleshy pulp, and seedlessness is a desirable trait that enhances commercial appeal.

123. (1) Banana
A true fruit develops exclusively from a fertilized ovary without the involvement of any other floral parts. Banana is considered a true fruit in this botanical sense, even if it is often seedless due to parthenocarpy. In contrast, fig, apple, and pear are false fruits. In apples, the fleshy edible part develops from the thalamus, while a fig develops from an inflorescence.

124. (2) inflorescence
Hypanthodium is a specialized type of inflorescence where the fleshy receptacle forms a hollow, flask-shaped cavity with a small apical opening. The male, female, and sterile flowers are borne on the inner surface of this cavity. This structure is characteristic of the genus Ficus. It is an adaptation for a unique pollination mechanism involving specific wasp species that enter the cavity.

NODIA

125. (1) Fabaceae
Pulses, which are important sources of plant-based protein, are obtained from members of the Fabaceae family. This family was formerly known as Leguminosae. Common examples include peas, beans, gram, and soybeans. These plants are characterized by their legume fruits and their ability to fix atmospheric nitrogen through symbiotic bacteria in root nodules. In contrast, Poaceae provides cereals and Solanaceae provides vegetables.

126. (1) Asteraceae
In the Asteraceae family, the stamens exhibit a syngenesious condition where the filaments are free but the anthers are fused together into a tube around the style. Additionally, these stamens are epipetalous, meaning they are attached to the petals. This arrangement is a key characteristic of the florets in the composite flower heads typical of this family for specialized pollination mechanisms.

127. (4) $\oplus\ \male\!\!\female\ K_{(5)}\ C_{(5)}\ A_5\ G_{(2)}$
Tomato and tobacco belong to the Solanaceae family. Their flowers are actinomorphic and bisexual. The formula indicates five fused sepals, five fused petals, and five stamens that are epipetalous. The gynoecium is bicarpellary and syncarpous with a superior ovary. This specific set of characters, particularly the fusion of floral parts and organ count, is a diagnostic feature for the nightshade family.

128. (4) aerial roots of orchids
Velamen is a specialized, multi-layered spongy tissue found on the outer surface of the aerial roots of many epiphytic orchids. Its primary function is to absorb moisture and nutrients from the atmosphere, as these plants do not have access to soil. The hygroscopic nature of velamen allows it to rapidly soak up rainwater or dew in forest canopy environments.

129. (2) drupe
The fruit of Mangifera indica, commonly known as mango, is a drupe. Drupes are fleshy fruits that develop from a monocarpellary superior

ovary. They are characterized by having a pericarp differentiated into three layers: a thin outer epicarp, a fleshy edible mesocarp, and a hard stony endocarp that protects the single seed. This fruit structure is also seen in coconut.

130. (2) Solanaceae
The floral formula provided depicts an actinomorphic, bisexual flower with five fused sepals and five fused petals. It also shows five epipetalous stamens and a bicarpellary, syncarpous, superior ovary. This specific combination of traits is the definitive diagnostic characteristic for the Solanaceae family. Liliaceae flowers are trimerous, and Fabaceae flowers are zygomorphic with a monocarpellary ovary, distinguishing them clearly.

131. (4) Asteraceae
The condition where stamens are attached to the petals is called epipetalous, and where anthers are fused into a tube while filaments remain free is called syngenesious. This combination is a hallmark of the Asteraceae family, also known as the Compositae family. While Solanaceae members have epipetalous stamens, they typically lack the syngenesious fusion of anthers, which identifies the daisy family.

132. (2) Asteraceae
The Asteraceae family is primarily defined and easily recognized by its unique inflorescence type, known as a capitulum or head. In this arrangement, many small individual flowers, called florets, are crowded together on a common receptacle and surrounded by an involucre of bracts. This specialized floral organization is a fundamental diagnostic feature that distinguishes Asteraceae from other families like Fabaceae or Solanaceae.

133. (1) Asteraceae
The syngenesious condition refers to an arrangement where the anthers of the stamens are fused together into a cylinder or tube, but their filaments remain separate and free. This is a characteristic feature of the Asteraceae family. This tube surrounds the style, and as the style grows, it pushes pollen out of the anther tube for dispersal in these composite flowers.

134. (2) sucker
New banana plants primarily develop from suckers, which are lateral branches that originate from the underground portion of the stem. These suckers grow obliquely upward and give rise to new leafy shoots. While bananas have an underground rhizome, it is the sucker that emerges as a new plant for propagation. Commercial bananas are typically seedless, so vegetative reproduction is required.

135. (4) cotyledons
In the groundnut, which is a non-endospermic legume, the endosperm is consumed during seed development. Consequently, the food and oil reserves are stored in the two large cotyledons. When we eat a peanut, we are primarily consuming these nutrient-rich cotyledons. The epicarp and mesocarp form the outer shell of the pod. This storage strategy is typical for the Fabaceae family.

136. (2) cotyledons
The oil reserve in a groundnut is located within the cotyledons of the seed. Groundnuts are classified as non-endospermic seeds because the endosperm is used up by the developing embryo before the seed matures. The two large cotyledons then become the primary storage organs for proteins and fats. This is why peanuts are a rich source of oil in the human diet.

137. (2) mesocarp
Mango juice is extracted from the middle layer of the fruit wall, known as the mesocarp. In a drupe like the mango, the pericarp is divided into an outer epicarp, a middle fleshy mesocarp, and an inner stony endocarp. The mesocarp is the succulent and fibrous part that stores the sugars and water making up the juice consumed after processing.

138. (1) legume
The fruit of the groundnut is technically a legume or pod. It develops from a monocarpellary superior ovary. A unique feature of groundnuts is their geocarpic nature, where the developing fruit is pushed underground to mature. Like other legumes, the pod typically contains seeds. This fruit type is the defining characteristic of the Fabaceae family, to which the groundnut plant belongs.

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CHAPTER 06
Anatomy of Flowering Plants

2026 (CANCELLED)

1. In angiosperms, root hairs arise from which one of the following regions of the root?
(1) The root cap zone
(2) The region of meristematic activity
(3) The region of elongation
(4) The region of maturation

2026 (CANCELLED)

2. The main function of bulliform cells in grasses is:
(1) to make the leaf impermeable to fungal spores
(2) to transport water
(3) to perform photosynthesis
(4) to minimize water loss during water stress

2026 (CANCELLED)

3. Match List I with List II:
List I:
A. Conjunctive tissue
B. Casparian strips
C. Subsidiary cells
D. Starch sheath
List II:
I. Specialised cells in the vicinity of guard cells
II. Endodermal cells rich in starch
III. Tissue between xylem and phloem
IV. Endodermal cells with suberin deposition
(1) A-IV, B-III, C-I, D-II
(2) A-III, B-IV, C-II, D-I
(3) A-III, B-IV, C-I, D-II
(4) A-IV, B-III, C-II, D-I

2025

4. Find the statement that is not correct with regard to the structure of monocot stem.
(1) Vascular bundles are conjoint and closed.
(2) Phloem parenchyma is absent.
(3) Hypodermis is parenchymatous.
(4) Vascular bundles are scattered.

RE-EXAM 2024

5. Which of the following simple tissues are commonly found in the fruit walls of nuts and pulp of pear?
(1) Sclereids
(2) Fibres
(3) Parenchyma
(4) Collenchyma

RE-EXAM 2024

6. Which one of the following is not found in gymnosperms?
(1) Sieve cells
(2) Albuminous cells
(3) Tracheids
(4) Vessels

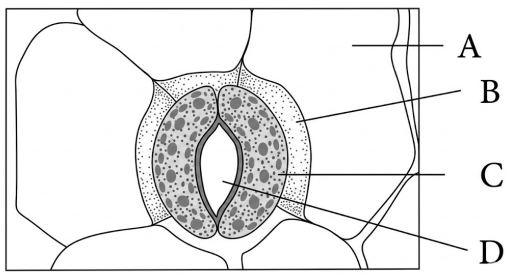
RE-EXAM 2024

7. Which of the following helps in maintenance of the pressure gradient in sieve tubes?
(1) Albuminous cells
(2) Sieve cells
(3) Phloem parenchyma
(4) Companion cells

NODIA

2024

8. In the given figure, which component has thin outer walls and highly thickened inner walls?



(1) C (2) D
(3) A (4) B

2024

9. Given below are two statements.
Statement I : Parenchyma is living but collenchyma is dead tissue.
Statement II : Gymnosperms lack xylem vessels but presence of xylem vessels is the characteristic of angiosperms.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are true.
(2) Both Statement I and Statement II are false.

(3) Statement I is true but Statement II is false.
(4) Statement I is false but Statement II is true.

RE-EXAM 2024

10. Given below are two statements.
Statement I : In a dicotyledonous leaf, the adaxial epidermis generally bears more stomata than the abaxial epidermis.
Statement II : In a dicotyledonous leaf, the adaxially placed palisade parenchyma is made up of elongated cells, which are arranged vertically and parallel to each other.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

2024

11. Bulliform cells are responsible for
(1) inward curling of leaves in monocots
(2) protecting the plant from salt stress
(3) increased photosynthesis in monocots
(4) providing large spaces for storage of sugars.

Manipur NEET 2023

12. Consider the following plant tissues:
A. Axillary buds
B. Fascicular vascular cambium
C. Interfascicular cambium
D. Cork cambium
E. Intercalary meristem
Identify the lateral meristems among the above.
(1) (A), (C) and (D) only
(2) (B), (C) and (D) only
(3) (A), (B), (C) and (E) only
(4) (A), (B), (D) and (E) only

2023

13. Given below are two statements.
Statement I : Endarch and exarch are the terms often used for describing the position of secondary xylem in the plant body.
Statement II : Exarch condition is the most common feature of the root system.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is correct but statement II is false.
(2) Statement I is incorrect but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

Manipur NEET 2023

14. The transverse section of a plant part showed polyarch, radial and exarch xylem, with endodermis and pericycle. The plant part is identified as
(1) monocot root
(2) dicot root
(3) dicot stem
(4) monocot stem.

Manipur NEET 2023

15. Consider the following tissues in the stelar region of a stem showing secondary growth.
A. Primary xylem
B. Secondary xylem
C. Primary phloem
D. Secondary phloem
Arrange these in the correct sequence of their position from pith towards cortex.
(1) (A), (B), (D), (C)
(2) (B), (A), (C), (D)
(3) (A), (B), (C), (D)
(4) (B), (A), (D), (C)

2023

16. Identify the correct statements.
A. Lenticels are the lens-shaped openings permitting the exchange of gases.
B. Bark formed early in the season is called hard bark.
C. Bark is a technical term that refers to all tissues exterior to vascular cambium.
D. Bark refers to periderm and secondary phloem.
E. Phellogen is single-layered in thickness.
Choose the correct answer from the options given below.
(1) A, B and D only
(2) B and C only
(3) B, C and E only
(4) A and D only

2023

17. Given below are two statements.
One is labelled as Assertion(A) and the other is labelled as Reason(R).
Assertion (A) : Late wood has fewer xylary elements with narrow vessels.
Reason(R) : Cambium is less active in winters.
In the light of the above statements, choose the correct answer from the options given below :
(1) (A) is true but (R) is false.
(2) (A) is false but (R) is true.
(3) Both (A) and (R) are true and (R) is the correct explanation of (A).

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(4) Both (A) and (R) are true but (R) is not the correct explanation of (A).

2022

18. Read the following statements about the vascular bundles.

A. In roots, xylem and phloem in a vascular bundle are arranged in an alternate manner along the different radii.
B. Conjoint closed vascular bundles do not possess cambium.
C. In open vascular bundles, cambium is present in between xylem and phloem.
D. The vascular bundles of dicotyledonous stem possess endarch protoxylem.
E. In monocotyledonous root, usually there are more than six xylem bundles present.

Choose the correct answer from the options given below.
(1) (A), (B) and (D) only
(2) (B), (C), (D) and (E) only
(3) (A), (B), (C) and (D) only
(4) (A), (C), (D) and (E) only

2022

19. In old trees the greater part of secondary xylem is dark brown and resistant to insect attack due to

A. secretion of secondary metabolities and their deposition in the lumen of vessels
B. deposition of organic compounds like tannins and resins in the central layers of stem
C. deposition of suberin and aromatic substances in the outer layer of stem
D. deposition of tannis, gum, resin and aromatic substances in the peripheral layers of stem
E. presence of parenchyma cells, functionally active xylem elements and essential oils

Choose the correct answer from the options given below.
(1) (A) and (B) only
(2) (C) and (D) only
(3) (D) and (E) only
(4) (B) and (D) only

2022

20. The anatomy of springwood shows some peculiar features. Identify the correct set of statement about springwood.

(A) It is also called as the earlywood.
(B) In spring season cambium produces elements with narrow vessels.
(C) It is lighter in colour.
(D) The springwood along with autumn shows alternate concentric rings for annual rings.
(E) It has lower density.

Choose the correct answer from the options below.
(1) (A), (B), (D) and (E) only
(2) (A), (C), (D) and (E) only
(3) (A), (B) and (D) only
(4) (C), (D) and (E) only

2021

21. Match List-I with List-II.

	List-I		List-II
(p)	Cells with active cell division capacity	(i)	Vascular tissues
(q)	Tissue having all cells similar in structure and function	(ii)	Meristematic tissue
(r)	Tissue having different types of cells	(iii)	Sclereids
(s)	Dead cells with highly thickened walls and narrow lumen	(iv)	Simple tissue

Select the correct answer from the options given below.
(1) (p)-(iii), (q)-(ii), (r)-(iv), (s)-(i)
(2) (p)-(ii), (q)-(iv), (r)-(i), (s)-(iii)
(3) (p)-(iv), (q)-(iii), (r)-(ii), (s)-(i)
(4) (p)-(i), (q)-(ii), (r)-(iii), (s)-(iv)

2021

22. Match List-I with List-II.

	List-I		List-II
(p)	Lenticels	(i)	Phellogen
(q)	Cork cambium	(ii)	Suberin deposition
(r)	Secondary cortex	(iii)	Exchange of gases
(s)	Cork	(iv)	Phelloderm

Choose the correct answer from the options given below.
(1) (p)-(iv), (q)-(ii), (r)-(i), (s)-(iii)
(2) (p)-(iv), (q)-(i), (r)-(iii), (s)-(ii)
(3) (p)-(iii), (q)-(i), (r)-(iv), (s)-(ii)
(4) (p)-(ii), (q)-(iii), (r)-(iv), (s)-(i)

NODIA

Karnataka NEET 2013

47. Meristematic tissue responsible for increase in girth of tree trunk is
(1) intercalary meristem
(2) lateral meristem
(3) phellogen
(4) apical meristem.

Karnataka NEET 2013

48. Which of the following statements is not true for stomatal apparatus?
(1) Guard cells invariably possess chloroplasts and mitochondria.
(2) Guard cells are always surrounded by subsidiary cells.
(3) Stomata are involved in gaseous exchange.
(4) Inner wall of guard cells are thick.

2013

49. Lenticels are involved in
(1) food transport
(2) photosynthesis
(3) transpiration
(4) gaseous exchange.

2013

50. Age of a tree can be estimated by
(1) number of annual rings
(2) diameter of its heartwood
(3) its height and girth
(4) biomass.

2013

51. Interfascicular cambium develops from the cells of
(1) endodermis
(2) pericycle
(3) medullary rays
(4) xylem parenchyma.

2012

52. Gymnosperms are also called soft wood spermatophytes because they lack
(1) cambium
(2) phloem fibres
(3) thick-walled tracheids
(4) xylem fibres.

2012

53. Companion cells are closely associated with
(1) sieve elements
(2) vessel elements
(3) trichomes
(4) guard cells.

2012

54. Closed vascular bundles lack
(1) ground tissue
(2) conjunctive tissue
(3) cambium
(4) pith.

2012

55. Water containing cavities in vascular bundles are found in
(1) sunflower
(2) maize
(3) Cycas
(4) Pinus.

Mains 2012

56. As compared to a dicot root, a monocot root has
(1) more abundant secondary xylem
(2) many xylem bundles
(3) inconspicuous annual rings
(4) relatively thicker periderm.

2012

57. The common bottle cork is a product of
(1) dermatogen
(2) phellogen
(3) xylem
(4) vascular cambium.

Mains 2011

58. Function of companion cells is
(1) providing energy to sieve elements for active transport
(2) providing water to phloem
(3) loading of sucrose into sieve elements by passive transport
(4) loading of sucrose into sieve elements.

2011

59. Ground tissue includes
(1) all tissues external to endodermis
(2) all tissues except epidermis and vascular bundles
(3) epidermis and cortex
(4) all tissues internal to endodermis.

Mains 2011

60. Some vascular bundles are described as open because these
(1) are surrounded by pericycle but no endodermis
(2) are capable of producing secondary xylem and phloem
(3) possess conjunctive tissue between xylem and phloem
(4) are not surrounded by pericycle.

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2018

34. Plants having little or no secondary growth are
(1) grasses
(2) deciduous angiosperms
(3) conifers
(4) cycads.

2017

35. Root hair develop from the region of
(1) elongation
(2) root cap
(3) meristematic activity
(4) maturation.

2017

36. The vascular cambium normally gives rise to
(1) primary phloem
(2) secondary xylem
(3) periderm
(4) phelloderm.

2017

37. Which of the following is made up of dead cells?
(1) Collenchyma
(2) Phellem
(3) Phloem
(4) Xylem parenchyma

2017

38. Identify the wrong statement in context of heartwood.
(1) It is highly durable.
(2) It conducts water and minerals efficiently.
(3) It comprises dead elements with highly lignified walls.
(4) Organic compounds are deposited in it.

NEET-I 2016

39. Specialised epidermal cells surrounding the guard cells are called
(1) bulliform cells
(2) lenticels
(3) complementary cells
(4) subsidiary cells.

NEET-II 2016

40. Cortex is the region found between
(1) epidermis and stele
(2) pericycle and endodermis
(3) endodermis and pith
(4) endodermis and vascular bundle.

NEET-II 2016

41. The balloon-shaped structures called tyloses
(1) originate in the lumen of vessels
(2) characterise the sapwood
(3) are extensions of xylem parenchyma cells into vessels
(4) are linked to the ascent of sap through xylem vessels.

2015 Cancelled

42. Vascular bundles in monocotyledons are considered closed because
(1) there are no vessels with perforations
(2) xylem is surrounded all around by phloem
(3) a bundle sheath surrounds each bundle
(4) cambium is absent.

2015 Cancelled

43. A major characteristic of monocot root is the presence of
(1) vasculature without cambium
(2) cambium sandwiched between phloem and xylem along the radius
(3) open vascular bundles
(4) scattered vascular bundles.

NODIA

2015

44. Read the different components from (i) to (iv) in the list given below and tell the correct order of the components with reference to their arrangement from outer side to inner side in a woody dicot stem.
(i) Secondary cortex
(ii) Wood
(iii) Secondary phloem
(iv) Phellem
The correct order is
(1) (iv), (i), (iii), (ii)
(2) (iv), (iii), (i), (ii)
(3) (iii), (iv), (ii), (i)
(4) (i), (ii), (iv), (iii).

2014

45. Tracheids differ from other tracheary elements in
(1) having Casparian strips
(2) being imperforate
(3) lacking nucleus
(4) being lignified.

2014

46. You are given a fairly old piece of dicot stem and a dicot root. Which of the following anatomical structures will you use to distinguish between the two?
(1) Secondary xylem
(2) Secondary phloem
(3) Protoxylem
(4) Cortical cells

(3) central region of style through which the pollen tube grows towards the ovary
(4) endodermis of roots facilitating rapid transport of water from cortex to pericycle.

2007

74. For a critical study of secondary growth in plants, which one of the following pairs is suitable?
(1) Teak and pine
(2) Deodar and fern
(3) Wheat and maiden hair fern
(4) Sugarcane and sunflower

2006

75. A common structural feature of vessel elements and sieve tube elements is
(1) enucleate condition
(2) thick secondary walls
(3) pores on lateral walls
(4) presence of P-protein.

2005

76. In a woody dicotyledonous tree, which of the following parts will mainly consist of primary tissues?
(1) All parts
(2) Stem and root
(3) Flowers, fruits and leaves
(4) Shoot tips and root tips

2003

77. The apical meristem of the root is present
(1) only in radicals
(2) only in tap roots
(3) only in adventitious roots
(4) in all the roots.

2003

78. Chlorenchyma is known to develop in the
(1) cytoplasm of Chlorella
(2) mycelium of a green mould such as Aspergillus
(3) spore capsule of a moss
(4) pollen tube of Pinus.

2003

79. The cells of the quiescent centre are characterised by
(1) having dense cytoplasm and prominent nuclei
(2) having light cytoplasm and small nuclei
(3) dividing regularly to add to the corpus
(4) dividing regularly to add to tunica.

2003

80. Diffuse porous woods are characteristic of plants growing in
(1) alpine region
(2) cold winter regions
(3) temperature climate
(4) tropics.

2002

81. Which of the following statements is true?
(1) Vessels are multicellular with wide lumen.
(2) Tracheids are multicellular with narrow lumen.
(3) Vessels are unicellular with narrow lumen.
(4) Tracheids are unicellular with wide lumen.

2002

82. Axillary bud and terminal bud derived from the activity of
(1) lateral meristem
(2) intercalary meristem
(3) apical meristem
(4) parenchyma.

2002

83. Vessels are found in
(1) all angiosperms and some gymnosperms
(2) most of angiosperms and few gymnosperms
(3) all angiosperms, all gymnosperms and some pteridophyta
(4) all pteridophyta.

2002

84. Four radial vascular bundle are found in
(1) dicot root (2) monocot root
(3) dicot stem (4) monocot stem.

2000

85. What happens in plants during vascularisation?
(1) Differentiation of procambium, formation of primary phloem followed by formation of primary xylem
(2) Differentiation of procambium followed by the formation of primary phloem and xylem simultaneously
(3) Formation of procambium, primary phloem and xylem simultaneously
(4) Differentiation of procambium followed by the formation of secondary xylem

1999

86. Casparian strips are found in
(1) epidermis
(2) hypodermis
(3) periderm
(4) endodermis.

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2011

61. The cork cambium, cork and secondary cortex are collectively called
(1) phelloderm
(2) phellogen
(3) periderm
(4) phellem.

2010

62. Which one of the following is not a lateral meristem?
(1) Intrafascicular cambium
(2) Interfascicular cambium
(3) Phellogen
(4) Intercalary meristem

2010

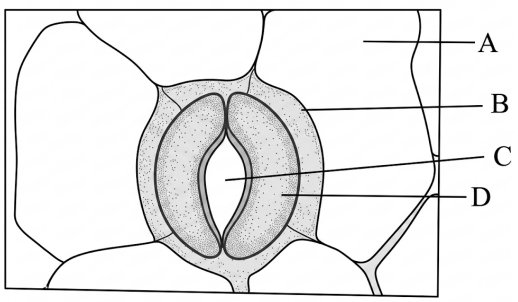
63. The chief water conducting elements of xylem in gymnosperms are
(1) vessels
(2) fibres
(3) transfusion tissue
(4) tracheids.

Mains 2010

64. Transport of food material in higher plants takes place through
(1) companion cells
(2) transfusion tissue
(3) tracheids
(4) sieve elements.

Mains 2010

65. Given below is the diagram of a stomatal apparatus. In which of the following all the four parts labelled as A, B, C and D are correctly identified?



(1) A-Subsidiary cell; B-Epidermal cell; C-Guard cell; D-Stomatal aperture
(2) A-Guard cell; B-Stomatal aperture; C-Subsidiary cell; D-Epidermal cell
(3) A-Epidermal cell; B-Guard cell; C-Stomatal aperture; D-Subsidiary cell
(4) A-Epidermal cell; B-Subsidiary cell; C-Stomatal aperture; D-Guard cell

2010

66. Heartwood differs from sapwood in
(1) presence of rays and fibres
(2) absence of vessels and parenchyma
(3) having dead and non-conducting elements
(4) being susceptible to pests and pathogens.

2009

67. In barley stem vascular bundles are
(1) closed and scattered
(2) open and in a ring
(3) closed and radial
(4) open and scattered.

2009

68. Palisade parenchyma is absent in leaves of
(1) mustard (2) soybean
(3) gram (4) Sorghum.

2009

69. The annular and spirally thickened conducting elements generally develop in the protoxylem when the root or stem is
(1) elongating
(2) widening
(3) differentiating
(4) maturing.

2009

70. Anatomically fairly old dicotyledonous root is distinguished from the dicotyledonous stem by
(1) absence of secondary phloem
(2) presence of cortex
(3) position of protoxylem
(4) absence of secondary xylem.

2008

71. The length of different internodes in a culm of sugarcane is variable because of
(1) size of leaf lamina at the node below each internode
(2) intercalary meristem
(3) shoot apical meristem
(4) position of axillary buds.

2008

72. Vascular tissues in flowering plants develop from
(1) periblem (2) dermatogen
(3) phellogen (4) plerome.

2007

73. Passage cells are thin walled cells found in
(1) phloem elements that serve as entry points for substance for transport to other plant parts
(2) testa of seeds to enable emergence of growing embryonic axis during seed germination

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ANSWERS

1. (4) The region of maturation
Root hairs are unicellular outgrowths of epidermal cells called epiblema. They develop only in the region of maturation (differentiation), located just behind the elongation zone. Here cells mature and form root hairs that absorb water and minerals from the soil, increasing surface area.

2. (4) to minimize water loss during water stress
Bulliform cells are large, empty, colourless epidermal cells found in grass leaves. During water stress they lose turgor, causing the leaf to roll inward. This curling reduces the exposed surface area and transpiration, thereby minimizing water loss and helping the plant conserve water.

3. (3) A-III, B-IV, C-I, D-II
Conjunctive tissue lies between xylem and phloem. Casparian strips are endodermal cells with suberin deposition. Subsidiary cells are specialised cells surrounding the guard cells. Starch sheath refers to endodermal cells rich in starch. This gives the matching A-III, B-IV, C-I, D-II.

4. (3) Hypodermis is parenchymatous.
In monocotyledonous stems, the hypodermis is typically composed of sclerenchyma cells rather than parenchyma. This provides mechanical strength to the plant. Other characteristic features include the presence of numerous scattered vascular bundles, each surrounded by a bundle sheath. Furthermore, phloem parenchyma is characteristically absent in these stems, and the vascular bundles are described as being conjoint and closed.

5. (1) Sclereids
Sclereids are a type of sclerenchyma cell characterized by highly thickened, lignified walls and very narrow lumens. They are commonly found in the fruit walls of nuts and provide the gritty texture in the pulp of fruits like pears, guavas, and sapotas. These cells are generally dead at maturity and function primarily to provide mechanical support to the tissues.

6. (4) Vessels
Gymnosperms are vascular plants that typically lack xylem vessels in their wood, relying instead on tracheids for water conduction. Their phloem also differs from angiosperms as it lacks sieve tubes and companion cells, containing sieve cells and albuminous cells instead. The absence of vessels is a key anatomical distinction, although some exceptions exist within the specialized group known as Gnetales.

7. (4) Companion cells
Companion cells are specialized parenchymatous cells closely associated with sieve tube elements in the phloem of angiosperms. They are connected to sieve tubes via pit fields in their common longitudinal walls. These cells play a crucial role in loading and unloading sugars, which helps in maintaining the necessary pressure gradient required for the efficient translocation of food throughout the plant.

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8. (1) C
Guard cells are specialized epidermal cells that regulate the opening and closing of stomata. These cells possess a unique wall structure where the outer walls, away from the stomatal pore, are thin and elastic. In contrast, the inner walls facing the pore are significantly thickened and less flexible. This differential thickening is essential for the osmotic mechanism of stomatal movement.

9. (4) Statement I is false but Statement II is true.
Parenchyma and collenchyma are both simple permanent tissues that remain living at maturity, providing metabolic functions and mechanical support respectively. Therefore, the claim that collenchyma is dead tissue is factually incorrect. In the vascular system, the absence of xylem vessels is a defining feature of most gymnosperms, whereas their presence is a characteristic hallmark of the angiosperm wood.

10. (2) Statement I is false but statement II is true.
In dicotyledonous leaves, the distribution of stomata is typically higher on the abaxial or lower epidermis to reduce water loss. The mesophyll is differentiated into palisade and

1998

87. Which of the following meristems is responsible for extrastelar secondary growth in dicotyledonous stem?
(1) Interfascicular cambium
(2) Intercalary meristem
(3) Phellogen
(4) Intrafascicular cambium

1998

88. The periderm includes
(1) secondary phloem
(2) cork
(3) cambium
(4) all of these.

1997

89. At maturity, which of the following is non-nucleated?
(1) Palisade cell
(2) Cortical cell
(3) Sieve cell
(4) Companion cell

1996

90. Which of the following is not true about 'sclereids'?
(1) These are groups of living cells.
(2) These are found in nut shells, guava pulp, pear.
(3) These are also called stone cells.
(4) These are form of sclerenchyma with fibres.

1994

91. Casparian strip occurs in a
(1) endodermis
(2) exodermis
(3) pericycle
(4) epidermis.

1994

92. A plant bears fruit, has a column of vascular tissue and a tap root system. This plant is a
(1) angiosperm and dicot
(2) gymnosperm and dicot
(3) angiosperm and monocot
(4) gymnosperm and monocot.

1994, 1990

93. Where do the Casparian bands occur?
(1) Epidermis
(2) Endodermis
(3) Pericycle
(4) Phloem

1994

94. As a tree grows older, which of the following increases more rapidly in thickness?
(1) Heartwood
(2) Sapwood
(3) Phloem
(4) Cortex

1993

95. Which of the following plant cells will show totipotency?
(1) Sieve tubes
(2) Xylem vessels
(3) Meristem
(4) Cork cells

1993

96. Bordered pits are found in
(1) sieve cells
(2) vessel wall
(3) companion cells
(4) sieve tube wall.

1993

97. A narrow layer of thin walled cells found between phloem/bark and wood of a dicot is
(1) cork cambium
(2) vascular cambium
(3) endodermis
(4) pericycle.

1993

98. Periderm is produced by
(1) vascular cambium
(2) fascicular cambium
(3) phellogen
(4) intrafascicular cambium.

1993

99. Which exposed wood will decay faster?
(1) Sapwood
(2) Softwood
(3) Wood with lot of fibres
(4) Heartwood

1993

100. Abnormal/anomalous secondary growth occurs in
(1) Dracaena (2) ginger
(3) wheat (4) sunflower.

1992

101. A bicollateral vascular bundle is characterised by
(1) phloem being sandwiched between xylem
(2) transverse splitting of vascular bundle
(3) longitudinal splitting of vascular bundle
(4) xylem being sandwiched between phloem.

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1992, 1990

102. What is true about a monocot leaf?
(1) Reticulate venation
(2) Absence of bulliform cells from epidermis
(3) Mesophyll not differentiated into palisade and spongy tissues
(4) Well differentiated mesophyll

1992, 1990

103. Vascular cambium produces
(1) primary xylem and primary phloem
(2) secondary xylem and secondary phloem
(3) primary xylem and secondary phloem
(4) secondary xylem and primary phloem.

1991

104. An organised and differentiated cellular structure having cytoplasm but no nucleus is
(1) vessels
(2) xylem parenchyma
(3) sieve tubes
(4) tracheids.

1991

105. Angular collenchyma occurs in
(1) Cucurbita
(2) Helianthus
(3) Althaea
(4) Salvia.

1990

106. Collenchyma occurs in
(1) herbaceous climbers
(2) woody climbers
(3) climbing stems
(4) water plants.

1990

107. Collenchyma occurs in the stem and petioles of
(1) xerophytes
(2) monocots
(3) dicot herbs
(4) hydrophytes.

1990

108. Cork cambium and vascular cambium are
(1) parts of secondary xylem and phloem
(2) parts of pericycle
(3) lateral meristem
(4) apical meristem.

1990

109. Pericycle of roots produces
(1) mechanical support
(2) lateral roots
(3) vascular bundles
(4) adventitious buds.

1990

110. Monocot leaves possess
(1) intercalary meristem
(2) lateral meristem
(3) apical meristem
(4) mass meristem.

1989

111. Sieve tubes are suited for translocation of food because they possess
(1) bordered pits
(2) no end walls
(3) broader lumen and perforated cross walls
(4) no protoplasm.

1989

112. Death of protoplasm is a pre-requisite for a vital function like
(1) transport of sap
(2) transport of food
(3) absorption of water
(4) gaseous exchange.

1989

113. Out of diffuse porous and ring porous woods, which is correct?
(1) Ring porous wood carries more water for short period.
(2) Diffuse porous wood carries more water.
(3) Ring porous wood carries more water when need is higher.
(4) Diffuse porous wood is less specialised but conducts water rapidly throughout.

1988

114. Organisation of stem apex into corpus and tunica is determined mainly by
(1) planes of cell division
(2) regions of meristematic activity
(3) rate of cell growth
(4) rate of shoot tip growth.

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1988

115. Which meristem helps in increasing girth?
(1) Lateral meristem
(2) Intercalary meristem
(3) Primary meristem
(4) Apical meristem

1988

116. Tunica corpus theory is connected with
(1) root apex
(2) root cap
(3) shoot apex
(4) secondary growth.

1988

117. Pith and cortex do not differentiate in
(1) monocot stem
(2) dicot stem
(3) monocot root
(4) dicot root.

1988

118. Cork is formed from
(1) cork cambium (phellogen)
(2) vascular cambium
(3) phloem
(4) xylem.

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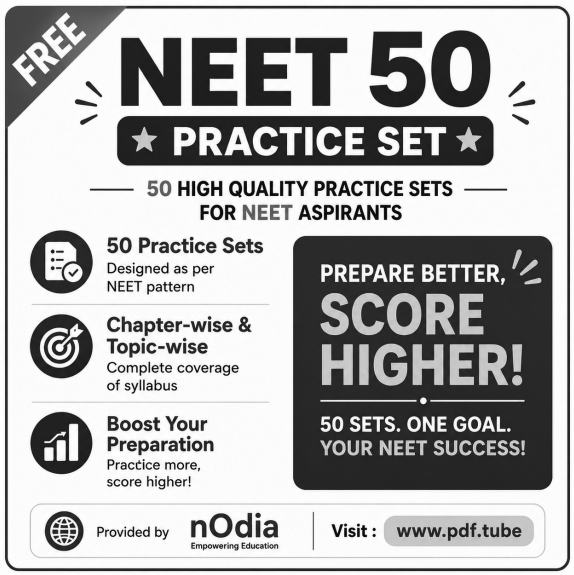

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2021

23. Select the correct pair.
(1) Loose parenchyma cells rupturing the epidermis and forming a lens-shaped opening in bark - Spongy parenchyma
(2) Large colorless empty cells in the epidermis of grass leaves - Subsidiary cells
(3) In dicot leaves, vascular bundles are surrounded by large thick-walled cells - Conjunctive tissue
(4) Cells of medullary rays that form part of cambial ring - Interfascicular cambium

2020

24. The transverse section of a plant shows following anatomical features :
(i) Large number of scattered vascular bundles surrounded by bundle sheath
(ii) Large conspicuous parenchymatous ground tissue
(iii) Vascular bundles conjoint and closed
(iv) Phloem parenchyma absent
Identify the category of plant and its part.
(1) Monocotyledonous stem
(2) Monocotyledonous root
(3) Dicotyledonous stem
(4) Dicotyledonous root

2020

25. Identify the incorrect statement.
(1) Heartwood does not conduct water but gives mechanical support.
(2) Sapwood is involved in conduction of water and minerals from root to leaf.
(3) Sapwood is the innermost secondary xylem and is lighter in colour.
(4) Due to deposition of tannins, resins, oils, etc., heartwood is dark in colour.

2019

26. Phloem in gymnosperms lacks
(1) both sieve tubes and companion cells
(2) albuminous cells and sieve cells
(3) sieve tubes only
(4) companion cells only.

Odisha NEET 2019

27. Regeneration of damaged growing grass following grazing is largely due to
(1) lateral meristem
(2) apical meristem
(3) intercalary meristem
(4) secondary meristem.

2019

28. Grass leaves curl inwards during very dry weather. Select the most appropriate reason from the following.
(1) Tyloses in vessels
(2) Closure of stomata
(3) Flaccidity of bulliform cells
(4) Shrinkage of air spaces in spongy mesophyll

Odisha NEET 2019

29. In the dicot root the vascular cambium originates from
(1) tissue located below the phloem bundles and a portion of pericycle tissue above protoxylem
(2) cortical region
(3) parenchyma between endodermis and pericycle
(4) intrafascicular and interfascicular tissue in a ring.

2019

30. Which of the statements given below is not true about formation of annual rings in trees?
(1) Annual rings are not prominent in trees of temperate region.
(2) Annual ring is a combination of spring wood and autumn wood produced in a year.
(3) Differential activity of cambium causes light and dark bands of tissue-early and late wood respectively.
(4) Activity of cambium depends upon variation in climate.

2018

31. Stomata in grass leaf are
(1) dumb-bell shaped
(2) kidney-shaped
(3) rectangular
(4) barrel-shaped.

2018

32. Casparian strips occur in
(1) epidermis
(2) pericycle
(3) cortex
(4) endodermis.

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2018

33. Secondary xylem and phloem in dicot stem are produced by
(1) apical meristems
(2) vascular cambium
(3) phellogen
(4) axillary meristems.

spongy parenchyma. The palisade parenchyma consists of vertically elongated cells arranged parallel to each other on the adaxial side. This arrangement optimizes light absorption for photosynthesis while the spongy layer facilitates gas exchange.

11. (1) inward curling of leaves in monocots
Bulliform cells are large, empty, colorless cells found in the upper epidermis of many monocot leaves, particularly grasses. When these cells lose water due to water stress, they become flaccid, causing the leaves to curl inwards. This physiological response minimizes the exposed surface area of the leaf, effectively reducing water loss through transpiration during periods of dry or hot weather.

12. (2) (B), (C) and (D) only
Lateral meristems are responsible for secondary growth, which increases the thickness or girth of the plant. This group includes the fascicular vascular cambium, the interfascicular cambium, and the cork cambium, also known as phellogen. These tissues occur in the mature regions of roots and shoots and appear later than the primary meristems, such as the apical and intercalary meristems, in life.

13. (2) Statement I is incorrect but statement II is true.
The terms endarch and exarch specifically describe the relative positions of protoxylem and metaxylem within the primary xylem. In stems, the protoxylem lies towards the center, creating an endarch condition. In roots, the protoxylem is located towards the periphery, which is known as the exarch condition. This arrangement is a standard anatomical feature that helps distinguish root systems from stem structures.

14. (1) monocot root
Monocotyledonous roots are characterized by a radial arrangement of vascular bundles where xylem and phloem alternate along different radii. The xylem is exarch, meaning the protoxylem is directed towards the periphery. A defining feature of these roots is the polyarch condition, which refers to the presence of more than six xylem bundles. These structures are enclosed within the endodermis and pericycle layers.

15. (1) (A), (B), (D), (C)
In a stem undergoing secondary growth, the vascular cambium produces secondary tissues between the primary layers. Starting from the pith and moving towards the cortex, the layers are arranged sequentially. The innermost layer is the primary xylem, followed by the secondary xylem. Moving further outwards, one encounters the secondary phloem, and finally, the primary phloem is located closest to the cortical region.

16. (4) A and D only
Lenticels are specialized lens-shaped openings in the bark that facilitate gaseous exchange between the atmosphere and the internal tissues of the stem. Bark is a non-technical term encompassing all tissues located outside the vascular cambium, specifically including the periderm and secondary phloem. While bark formed early in the season is called soft bark, that formed later is known as hard bark.

17. (3) Both (A) and (R) are true and (R) is the correct explanation of (A).
The activity of the vascular cambium is significantly influenced by seasonal environmental changes. During the winter season, the cambium becomes less active and produces fewer xylary elements. These elements, collectively known as late wood or autumn wood, typically feature vessels with narrow lumens and a higher density. This process is a physiological adaptation to the reduced metabolic requirements and water availability in winter.

18. (4) (A), (C), (D) and (E) only
Vascular bundles show various arrangements depending on the plant part. In roots, xylem and phloem are arranged radially. Dicot stems feature conjoint, open bundles with cambium, whereas monocot stems have closed bundles without cambium. The protoxylem is endarch in stems and exarch in roots. Furthermore, monocot roots are characterized by a polyarch condition, typically containing more than six xylem bundles.

19. (1) (A) and (B) only
In older trees, the innermost layers of secondary xylem undergo significant changes, leading to the formation of heartwood. This region becomes dark brown due to the deposition of organic compounds such as tannins, resins, oils, and gums. These substances make the wood

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wood dark, extremely durable, and resistant. Its primary function is to provide essential mechanical support and structural stability.

39. (4) subsidiary cells.
Subsidiary cells are specialized epidermal cells that are found in close proximity to the guard cells in the stomatal apparatus. They often differ in shape and size from the surrounding typical epidermal cells. These cells play a supportive role in the opening and closing of the stomatal pore by facilitating the movement of ions and water during various osmotic changes in guard cells.

40. (1) epidermis and stele
The cortex is a major tissue region in the primary body of roots and stems, located between the outermost epidermis and the central vascular cylinder, or stele. It primarily consists of parenchymatous cells but may also contain collenchyma or sclerenchyma for support. The innermost layer of the cortex is the endodermis. The cortex functions in food storage and internal water transport.

41. (3) are extensions of xylem parenchyma cells into vessels
Tyloses are balloon-like outgrowths that develop from the axial or ray parenchyma cells into the lumen of adjacent xylem vessels through pits. These structures are common in the heartwood of many woody plants. By blocking the vessels, tyloses effectively stop the conduction of water and protect the plant from pathogens. Their presence is a characteristic feature of the transition to heartwood.

42. (4) cambium is absent.
In plant anatomy, vascular bundles are classified as closed when they lack a layer of meristematic tissue known as cambium between the xylem and phloem. This condition is a hallmark of monocotyledonous plants. Because they lack cambium, these bundles are incapable of secondary growth, meaning they cannot produce secondary xylem or phloem to increase the stem's thickness or overall girth.

43. (1) vasculature without cambium
Monocotyledonous roots are characterized by several unique anatomical features. Unlike dicot roots, they generally have a large number of xylem bundles, often more than six, a condition termed polyarch. The vascular bundles are arranged radially, with xylem and phloem on different radii. Most significantly, these roots lack a vascular cambium, which means they do not undergo secondary growth throughout their development.

44. (1) (iv), (i), (iii), (ii)
In a woody dicotyledonous stem, the tissues are arranged in a specific sequence from the exterior to the interior. The outermost layer is the phellem or cork, which is followed by the phellogen and then the secondary cortex, also known as phelloderm. Moving deeper into the stem, one finds the secondary phloem. The innermost significant structural component in this list is wood.

45. (2) being imperforate
Tracheids and vessels are both types of tracheary elements in the xylem responsible for water conduction. A fundamental difference between them is that tracheids are individual, elongated cells with tapering ends and are imperforate, meaning they lack large openings or perforation plates. In contrast, vessel elements are joined end-to-end to form long tubes and possess perforation plates in their common longitudinal walls.

46. (3) Protoxylem
The position of the protoxylem relative to the metaxylem is a key anatomical feature used to distinguish between stems and roots. In dicotyledonous stems, the protoxylem is located towards the center of the vascular bundle, known as the endarch condition. Conversely, in dicotyledonous roots, the protoxylem is directed towards the periphery, described as exarch. This fundamental difference remains evident as plants age.

47. (2) lateral meristem
Secondary growth, which results in an increase in the thickness or girth of the tree trunk, is primarily driven by lateral meristems. These meristems include the vascular cambium and the cork cambium, or phellogen. They occur in the mature regions of the roots and shoots of gymnosperms and most dicotyledons. By producing new cells, lateral meristems allow woody plants to develop sturdy trunks.

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29. (1) tissue located below the phloem bundles and a portion of pericycle tissue above protoxylem
In dicotyledonous roots, the vascular cambium is entirely secondary in origin. It arises from the tissues located just below the phloem bundles and a portion of the pericycle tissue situated above the protoxylem. This initially forms a wavy continuous ring, which later becomes circular as secondary growth progresses. This development is crucial for the formation of secondary xylem and phloem tissues.

30. (1) Annual rings are not prominent in trees of temperate region.
Annual rings are prominent features in trees growing in temperate regions where climatic conditions vary significantly throughout the year. These rings consist of two types of wood: spring wood, formed during the highly active spring season, and autumn wood, produced when cambial activity slows down. The distinct appearance of these bands allows for the estimation of a tree's total age.

31. (1) dumb-bell shaped
In monocotyledonous plants like grasses, the guard cells of the stomatal apparatus exhibit a distinct dumb-bell shape. This is in contrast to the kidney or bean-shaped guard cells typically found in dicots. These specialized cells regulate the opening and closing of the stomatal pore to control gas exchange and transpiration. The unique shape is an anatomical adaptation in the Poaceae.

32. (4) endodermis
Casparian strips are specialized bands of waterproof, suberin-rich material found in the radial and tangential walls of endodermal cells. This layer acts as a biological checkpoint, forcing water and dissolved minerals to pass through the plasma membrane of endodermal cells instead of moving between them. This selective barrier ensures that the plant can regulate the uptake of substances into the stele.

33. (2) vascular cambium
The vascular cambium is a lateral meristem responsible for the secondary growth in dicotyledonous stems. It forms a continuous ring between the primary xylem and phloem. Through periclinal divisions, the cambium produces secondary xylem towards the inner side and secondary phloem towards the outer side. This process results in the thickening of the stem over time, a characteristic of woody plants.

34. (1) grasses
Secondary growth is the process by which plants increase their girth through the activity of lateral meristems like vascular cambium and cork cambium. While this is common in gymnosperms and most dicots, monocotyledonous plants like grasses typically lack these lateral meristems. As a result, grasses exhibit little to no secondary growth and maintain a relatively consistent stem diameter throughout their development.

35. (4) maturation.
Root hairs are unicellular elongations of the epidermal cells that significantly increase the surface area for water and mineral absorption. These structures develop specifically in the region of maturation, which is located behind the region of elongation. In this zone, the cells differentiate into various mature tissues. Root hairs are delicate and short-lived, continuously being replaced as the root tip grows.

36. (2) secondary xylem
The vascular cambium is a thin layer of meristematic tissue located between the xylem and phloem in dicot stems and roots. During secondary growth, its cells divide to produce secondary xylem towards the interior and secondary phloem towards the exterior of the plant. Since the cambium is more active on the inner side, the amount of secondary xylem produced is typically greater.

37. (2) Phellem
Phellem, commonly known as cork, is produced by the activity of the cork cambium or phellogen during secondary growth. As phellem cells mature, their walls become heavily impregnated with suberin, a waxy waterproof substance. This deposition eventually leads to the death of the protoplasm, making phellem a tissue composed of dead cells. It serves as a protective outer layer against water.

38. (2) It conducts water and minerals efficiently.
Heartwood is the older, central portion of the secondary xylem that has ceased to conduct water and minerals. It is characterized by the presence of dead elements with highly thickened, lignified walls. The deposition of various organic compounds like tannins and resins makes this

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95. (3) Meristem
Totipotency refers to the ability of a single plant cell to divide and differentiate into any type of cell, eventually regenerating an entire plant. In the plant body, meristematic cells are characterized by their active division and undifferentiated state, making them highly totipotent. While some mature cells can regain this ability, specialized or dead cells like xylem vessels generally lack this comprehensive capacity.

96. (2) vessel wall
Bordered pits are specialized structures in the cell walls of water-conducting elements, such as tracheids and vessels. These pits feature an overarching secondary wall that creates a chamber around the pit membrane. This design helps regulate water flow and prevents the spread of air bubbles between adjacent cells. While simple pits exist, bordered pits are particularly characteristic of the xylem vessels and tracheids.

97. (2) vascular cambium
In woody dicotyledonous stems, the vascular cambium is a thin layer of meristematic cells located between the phloem, which is part of the bark, and the wood, which is biologically the secondary xylem. This lateral meristem is responsible for secondary growth. By dividing, it produces new secondary xylem cells towards the inside and new secondary phloem cells towards the outside of the stem.

98. (3) phellogen
The periderm is the protective outer tissue system that replaces the epidermis in roots and stems undergoing secondary growth. It is produced by a specialized lateral meristem called the phellogen, or cork cambium. The phellogen cells divide to generate phellem towards the exterior and phelloderm towards the interior. This complex layer provides a durable, waterproof barrier that protects the plant's internal tissues.

99. (1) Sapwood
Sapwood is the younger, peripheral portion of the secondary xylem that remains functional in transporting water. Because it contains living parenchyma cells and lacks the protective depositions found in heartwood, such as tannins and resins, sapwood is much more susceptible to decay by fungi. Heartwood is composed of dead, lignified elements and is impregnated with chemical substances that make it highly durable.

100. (1) Dracaena
Secondary growth is typically absent in monocotyledonous plants because they lack a vascular cambium. However, some monocots like Dracaena exhibit a unique type of thickening known as anomalous secondary growth. In these plants, a specialized meristematic zone develops in the cortex, producing new vascular bundles. This process allows the stem to increase in girth through a mechanism that differs from typical dicot growth.

101. (4) xylem being sandwiched between phloem.
A bicollateral vascular bundle is a specialized type of vascular arrangement where the xylem is located in the middle, sandwiched between two layers of phloem. Specifically, there is an outer phloem and an inner phloem layer. This type of bundle also typically features two layers of cambium. Bicollateral bundles are characteristic features of certain plant families, most notably the Cucurbitaceae.

102. (3) Mesophyll not differentiated into palisade and spongy tissues
Monocotyledonous leaves, often called isobilateral leaves, show several distinct anatomical features compared to dicot leaves. One key characteristic is that the mesophyll tissue is relatively uniform and is not clearly differentiated into palisade and spongy layers. Additionally, monocot leaves typically exhibit parallel venation and often possess specialized bulliform cells in the epidermis. These features are adaptations to their environmental growth conditions.

103. (2) secondary xylem and secondary phloem
The vascular cambium is a layer of meristematic cells responsible for the secondary growth in dicotyledonous stems and roots. When these cells divide, they produce new tissues on both sides of the cambial ring. The cells formed towards the interior differentiate into secondary xylem, which becomes wood. Meanwhile, the cells produced towards the exterior differentiate into secondary phloem. This results in stem thickening.

104. (3) sieve tubes
Sieve tube elements are the primary conducting units of the phloem in angiosperms. During development, the sieve tube element loses its

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48. (2) Guard cells are always surrounded by subsidiary cells.
The stomatal apparatus consists of a stomatal pore, two specialized guard cells, and sometimes surrounding subsidiary cells. While subsidiary cells often accompany guard cells to aid in their function, they are not universally present in all plant species. Guard cells are unique among epidermal cells because they contain chloroplasts and mitochondria. Additionally, the inner walls of guard cells are characteristically thicker than outer.

49. (4) gaseous exchange.
Lenticels are small, lens-shaped pores that form in the bark of woody stems and roots. They are created when the phellogen produces loosely arranged parenchyma cells instead of cork cells, which eventually rupture the epidermis. These structures are essential for gaseous exchange, allowing oxygen and carbon dioxide to diffuse between the atmosphere and the internal tissues. They also permit some water loss.

50. (1) number of annual rings
The age of a tree can be accurately estimated by counting the number of annual rings visible in a cross-section of its trunk. Each annual ring typically represents one year of growth and consists of a layer of spring wood and a layer of autumn wood. This method, known as dendrochronology, is particularly effective for trees growing in temperate regions with seasonal changes.

51. (3) medullary rays
In dicotyledonous stems, the vascular cambium is initially present only within the vascular bundles as intrafascicular cambium. To form a complete cambial ring for secondary growth, the cells of the medullary rays located between adjacent vascular bundles become meristematic. These cells are then called the interfascicular cambium. The fusion of the intrafascicular and interfascicular cambium creates a continuous cylinder of meristematic tissue.

52. (4) xylem fibres.
Gymnosperms are often referred to as soft wood trees because their xylem is less complex than that of angiosperms. Specifically, the wood of gymnosperms lacks xylem vessels and typically contains few or no xylem fibres. Instead, it is primarily composed of tracheids, which perform both water conduction and mechanical support. The absence of these dense, thick-walled elements results in wood that is lighter.

53. (1) sieve elements
Companion cells are specialized parenchymatous cells found in the phloem of angiosperms that are intimately associated with sieve tube elements. They originate from the same mother cell as the sieve element they accompany. These cells maintain the metabolic functions of the enucleated sieve tubes and are involved in active loading and unloading. This relationship is essential for the efficient translocation of plant nutrients.

54. (3) cambium
Vascular bundles are described as closed when they do not contain a layer of meristematic cambium between the xylem and phloem tissues. This condition is characteristic of monocotyledonous plants. Because they lack this generative layer, closed vascular bundles cannot produce secondary xylem or secondary phloem. Consequently, plants with closed bundles are unable to undergo secondary growth and do not increase their girth.

55. (2) maize
In the vascular bundles of some monocotyledonous plants like maize, specific water-containing cavities known as protoxylem lacunae are present. These cavities are formed during development when the earliest-formed protoxylem vessels are stretched and eventually break apart as the stem elongates. These lacunae are located at the inner edge of the vascular bundles and serve as a characteristic anatomical feature of maize.

56. (2) many xylem bundles
Monocotyledonous roots can be distinguished from dicotyledonous roots by the number of xylem bundles they contain. Dicot roots typically have a limited number of xylem bundles, usually two to four, a condition known as diarch to tetrarch. In contrast, monocot roots are polyarch, meaning they possess a larger number of xylem bundles, often exceeding six. They also tend to have larger pith.

57. (2) phellogen
The common bottle cork is derived from the thick bark of the cork oak tree. It is produced by the activity of the phellogen, also known as

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the cork cambium. The phellogen is a lateral meristem that divides to produce phellem or cork cells towards the outside. These cells become impregnated with suberin, making them waterproof and resistant to decay during functional life.

58. (4) loading of sucrose into sieve elements.
Companion cells play a vital role in the transport of organic solutes within the phloem of angiosperms. Their primary function is to facilitate the loading of sucrose into the sieve tube elements from the surrounding leaf mesophyll cells. This process often involves active transport mechanisms. Since sieve tubes lack a nucleus at maturity, companion cells manage the metabolic requirements for these conducting structures.

59. (2) all tissues except epidermis and vascular bundles
The plant body is composed of three main tissue systems: the epidermal, the vascular, and the ground tissue system. Ground tissue is the most extensive of these and encompasses all tissues except for the epidermis and the vascular bundles. It includes several specialized regions such as the cortex, pericycle, pith, and medullary rays. In leaves, the ground tissue is represented by mesophyll cells.

60. (2) are capable of producing secondary xylem and phloem
Vascular bundles are classified as open when they possess a layer of meristematic tissue called vascular cambium between the xylem and phloem. This arrangement is typical of dicotyledonous stems and gymnosperms. The presence of cambium enables these bundles to undergo secondary growth by producing secondary xylem and secondary phloem. This process allows the plant to increase its diameter and develop sturdy wood.

61. (3) periderm
During secondary growth in woody plants, a protective tissue system called the periderm replaces the original epidermis. The periderm is composed of three distinct layers: the phellogen or cork cambium, the phellem or cork produced towards the outside, and the phelloderm or secondary cortex produced towards the inside. Collectively, these tissues provide a durable, waterproof barrier that protects internal tissues from water loss.

62. (4) Intercalary meristem
Lateral meristems are responsible for the secondary growth of plants, leading to an increase in girth. Common examples include the vascular cambium, which comprises intrafascicular and interfascicular cambium, and the cork cambium, known as phellogen. In contrast, the intercalary meristem is a primary meristem located at the base of leaves or internodes. It is responsible for longitudinal growth and regeneration of parts.

63. (4) tracheids.
In the vascular tissue of gymnosperms, tracheids serve as the primary elements for water conduction. Unlike angiosperms, most gymnosperms lack xylem vessels. Tracheids are elongated, dead cells with lignified walls and tapering ends. They are arranged in overlapping rows, and water moves between them through specialized pits. In addition to water transport, the thick walls of tracheids provide essential mechanical support to stems.

64. (4) sieve elements.
In higher plants, the translocation of organic food materials, such as sucrose, occurs through the phloem. The specialized conducting units of this tissue are the sieve elements, which include sieve tube elements in angiosperms and sieve cells in gymnosperms. These cells are characterized by their perforated end walls, known as sieve plates, which allow for flow. Translocation is supported by associated companion cells.

65. (4) Epidermal cell Subsidiary cell Stomatal aperture Guard cell
The stomatal apparatus is a complex of specialized cells in the plant epidermis. It includes the stomatal aperture, which is the actual pore for gas exchange. This pore is bordered by two guard cells that regulate its opening and closing. Surrounding the guard cells are subsidiary cells, which are modified epidermal cells. These components are embedded within the typical epidermal cell layer.

66. (3) having dead and non-conducting elements
As a tree ages, the secondary xylem is divided into heartwood and sapwood. Heartwood is the older, central part of the wood and consists entirely of dead, non-conducting elements. Its vessels are often blocked by tyloses and filled with resins. Sapwood is the younger, peripheral layer that remains active in transporting water.

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While heartwood provides mechanical strength, sapwood is essential for conduction.

67. (1) closed and scattered
Barley is a monocotyledonous plant, and its stem anatomy reflects typical monocot characteristics. In a transverse section of a barley stem, the vascular bundles are found scattered throughout the ground tissue rather than being in a ring. Furthermore, these vascular bundles are classified as closed because they lack a vascular cambium. This means barley stems do not undergo secondary growth throughout their life cycle.

68. (4) Sorghum.
Dicotyledonous leaves typically have a differentiated mesophyll consisting of palisade and spongy parenchyma. However, monocotyledonous plants like Sorghum possess isobilateral leaves where the mesophyll is not clearly differentiated into these two distinct layers. In such leaves, the parenchymatous cells between the upper and lower epidermis are uniform. This lack of palisade parenchyma is a characteristic feature that distinguishes monocot leaves.

69. (1) elongating
The early-formed primary xylem, known as protoxylem, develops when the plant organ is still undergoing elongation. To accommodate this rapid growth, the protoxylem vessels feature extensible wall thickenings, such as annular or spiral patterns. These designs allow cells to stretch without collapsing or losing function. As elongation ends, the later-formed metaxylem develops more rigid, non-extensible thickening patterns for greater structural support.

70. (3) position of protoxylem
Even in older plants, the primary vascular arrangement remains a reliable way to distinguish between root and stem anatomy. In dicotyledonous roots, the xylem is organized in an exarch manner, where the protoxylem is located towards the periphery. In contrast, dicotyledonous stems exhibit an endarch arrangement, with the protoxylem positioned towards the center. This fundamental difference persists even after secondary growth.

71. (2) intercalary meristem
The stem of sugarcane, known as a culm, consists of distinct nodes and internodes. The variation in the length of these internodes is primarily due to the activity of the intercalary meristem. This specialized meristematic tissue is located at the base of the internodes and is responsible for their elongation. Environmental factors can influence the rate of division in these cells, leading to internodes.

72. (4) plerome.
According to the histogen theory, the plant shoot and root apices are organized into three distinct histogens. The dermatogen gives rise to the epidermis, the periblem forms the cortex, and the plerome is responsible for the development of the central stele. The vascular tissues, including xylem and phloem, originate from the cells of the plerome. This organized differentiation ensures proper development.

73. (4) endodermis of roots facilitating rapid transport of water from cortex to pericycle.
Passage cells are specialized, thin-walled endodermal cells found in the roots of many plants. Unlike typical endodermal cells with suberized walls, passage cells remain unthickened. They are usually located opposite the protoxylem points. Their primary function is to provide a low-resistance pathway for the transport of water and dissolved minerals from the cortex into the vascular cylinder for upward conduction.

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74. (1) Teak and pine
Secondary growth is a characteristic feature of most dicotyledonous plants and gymnosperms, allowing them to increase in girth. To study this process effectively, one should choose species with well-defined secondary tissues. Teak, a prominent dicot, and Pine, a representative gymnosperm, are both excellent subjects. They both possess a vascular cambium that produces secondary xylem and phloem, as well as a cork cambium.

75. (1) enucleate condition
Vessel elements in the xylem and sieve tube elements in the phloem are both highly specialized conducting cells. Despite their different functions, they share a notable structural feature: they both lack a nucleus at maturity. In vessel elements, this occurs because

the cell dies to become a conduit. In sieve tube elements, the cell remains living but loses its nucleus for transport efficiency.

76. (3) Flowers, fruits and leaves
In a woody dicotyledonous tree, secondary growth is concentrated in the stems and roots through the activity of lateral meristems. However, certain organs like flowers, fruits, and leaves are primarily composed of primary tissues derived from the apical meristems. These parts usually have a limited lifespan and do not undergo the thickening associated with secondary growth, maintaining their primary anatomical structure.

77. (4) in all the roots.
The root apical meristem is a region of actively dividing cells located at the very tip of a root, just behind the root cap. This meristem is a fundamental feature of all root types, including tap roots, adventitious roots, and radicals. It is responsible for the primary growth of the root system, allowing roots to penetrate deeper into the soil.

78. (3) spore capsule of a moss
Chlorenchyma is a specialized type of parenchyma tissue that contains chloroplasts and is responsible for performing photosynthesis. This tissue typically develops in the green parts of plants, such as the mesophyll. In bryophytes like mosses, chlorenchyma is found in the wall of the spore capsule. This allows the developing capsule to produce its own organic nutrients during the process of maturation.

79. (2) having light cytoplasm and small nuclei
The quiescent centre is a region of slowly dividing cells located in the center of the root apical meristem. These cells are characterized by having relatively light cytoplasm, small nuclei, and low metabolic activity. They remain largely inactive during normal growth but can become meristematic to replace damaged cells in the active zones. This reserve acts as a protective mechanism for the root.

80. (4) tropics.
Diffuse porous wood is characterized by vessels that are relatively uniform in size and distributed evenly throughout the growth ring. This type of wood typically forms in plants growing in tropical regions where climatic conditions are fairly constant. In contrast, plants in temperate regions produce ring-porous wood. The anatomical pattern of wood reflects the environmental influence on vascular cambium activity and development.

81. (1) Vessels are multicellular with wide lumen.
Vessels are complex water-conducting structures formed by the fusion of multiple individual cells known as vessel elements. This multicellular arrangement creates long tubes with a wide lumen and perforated end walls, which facilitates efficient transport. In contrast, tracheids are unicellular cells with tapering ends and narrower lumens. Both are dead at maturity and have lignified walls for essential structural support and durability.

82. (3) apical meristem
Apical meristems are located at the tips of shoots and roots and are responsible for the primary growth of the plant body. During the growth of the shoot, some cells are left behind at the nodes. These cells form axillary buds, which are capable of developing into branches. Similarly, the terminal bud is a product of the shoot apical meristem's activity.

83. (2) most of angiosperms and few gymnosperms
Xylem vessels are a hallmark of the vast majority of angiosperms, providing an efficient system for water transport. While most gymnosperms and pteridophytes lack vessels, there are notable exceptions. For instance, vessels are found in the Gnetales, a specialized group of gymnosperms. Similarly, a few primitive angiosperms lack vessels. Thus, while vessels are characteristic of angiosperms, they appear in few gymnosperms.

84. (1) dicot root
In a transverse section of a dicotyledonous root, the vascular bundles are typically arranged in a radial pattern where xylem and phloem alternate. The number of xylem bundles is usually limited, often ranging from two to six. A root with four xylem bundles is described as being tetrarch. This is a common anatomical feature for many dicots compared to the polyarch monocot.

85. (1) Differentiation of procambium, formation of primary phloem followed by formation of primary xylem
Vascularisation is the developmental process by which primary vascular tissues are formed in a growing plant organ. This process begins with

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the differentiation of the procambium from the ground meristem. Subsequently, the first elements of the primary phloem begin to develop. This is followed by the formation of the first primary xylem elements, known as protoxylem. These tissues ensure a functional transport system.

86. (4) endodermis.
Casparian strips are specialized, waterproof bands of suberin and lignin found in the endodermis of roots. These strips are located on the radial and tangential walls of the endodermal cells. By blocking the apoplastic pathway, they force water and dissolved solutes to enter the symplastic pathway. This allows the plant to selectively regulate the substances entering the vascular cylinder from soil.

87. (3) Phellogen
Secondary growth in dicotyledonous stems occurs in the stellar and the extrastelar regions. Growth within the stele is driven by the vascular cambium, which produces secondary xylem and phloem. Extrastelar secondary growth is initiated by the activity of the cork cambium, also known as phellogen. This meristem develops from the cortex and produces phellem on its outer side and phelloderm inside.

88. (2) cork
As a woody plant undergoes secondary growth, the epidermis is eventually replaced by a protective layer called the periderm. The periderm is a complex tissue system consisting of three distinct components: the phellogen or cork cambium, the phellem or cork, and the phelloderm or secondary cortex. Cork cells are dead at maturity and suberized, providing an effective barrier against water loss.

89. (3) Sieve cell
Sieve cells are specialized conducting elements in the phloem of gymnosperms and primitive vascular plants. Like the sieve tube elements in angiosperms, sieve cells undergo a unique developmental process where they lose their nucleus at maturity. Despite being enucleated, these cells remain living and are responsible for translocation. They rely on the metabolic activity of associated albuminous cells to maintain their function.

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90. (1) These are groups of living cells.
Sclereids are a type of sclerenchyma tissue characterized by extremely thick, lignified cell walls and a very narrow lumen. These cells are typically dead at maturity and function primarily to provide mechanical strength. They are often called stone cells and are responsible for the gritty texture of fruits like pears, as well as the hardness of nut shells. Sclereids are not living.

91. (1) endodermis
The endodermis is the innermost layer of the root cortex and plays a critical role in controlling the movement of substances. This regulation is achieved through the presence of Casparian strips, which are bands of waterproof suberin deposited in the cell walls. These strips prevent the passive flow of water through cell walls, forcing movement through the selectively permeable plasma membranes instead.

92. (1) angiosperm and dicot
The presence of fruits is a defining characteristic of angiosperms, as they produce seeds within an ovary. A tap root system and a column of vascular tissue arranged in a ring within the stem are typical anatomical features of dicotyledonous plants. In contrast, monocots usually have fibrous roots and scattered vascular bundles. Therefore, a plant displaying these traits is a dicotyledonous angiosperm.

93. (2) Endodermis
Casparian bands, or strips, are characteristic features of the endodermis in plant roots. These bands are composed of suberin and lignin, which are deposited in the cell walls to create a waterproof barrier. By interrupting the apoplastic movement of water and minerals, the endodermis ensures that all substances entering the vascular cylinder are filtered through the living protoplasm of the cells.

94. (1) Heartwood
As a woody tree ages and undergoes secondary growth, the vascular cambium continuously produces new secondary xylem elements. Over time, the older, inner layers of this xylem cease to conduct water and transition into heartwood. This central core accumulates organic compounds, making it highly durable. While other tissues grow, the cumulative addition of xylem elements causes the heartwood to increase in thickness.

highly durable and resistant to attacks by microorganisms and insects. Heartwood consists of dead elements with highly lignified walls.

20. (2) (A), (C), (D) and (E) only
Springwood, also known as earlywood, is produced when the vascular cambium is highly active during the spring season. This wood is characterized by a large number of xylary elements having vessels with wider lumens. Consequently, springwood exhibits a lower density and a lighter color compared to autumn wood. Together, these two types of wood form concentric annual rings.

21. (2) (ii) (iv) (i) (iii)
Meristematic tissues consist of cells with a high capacity for active division, enabling plant growth. Simple tissues are composed of similar cells that perform a unified function, while complex tissues like vascular tissues contain various cell types. Sclereids are specialized sclerenchyma cells with thick, lignified walls and narrow lumens, providing mechanical strength. These different tissue types work together to facilitate plant integrity.

22. (3) (iii) (i) (iv) (ii)
Lenticels are openings in the bark that allow for gas exchange between the atmosphere and internal tissues. The cork cambium, or phellogen, is a lateral meristem responsible for producing the periderm. It generates the phellem or cork, which is characterized by suberin deposition, and the phelloderm or secondary cortex. These components collectively form the protective outer covering in woody plants.

23. (4) Cells of medullary rays that form part of cambial ring - Interfascicular cambium
The formation of a continuous cambial ring in dicot stems involves the activation of cells between existing vascular bundles. Specifically, the cells of the medullary rays located adjacent to the intrafascicular cambium become meristematic. These newly active cells are known as the interfascicular cambium. This process is essential for initiating secondary growth, allowing the stem to increase in its overall thickness.

24. (1) Monocotyledonous stem
Monocotyledonous stems are identified by several distinct anatomical characteristics visible in a transverse section. These include a large number of scattered vascular bundles, each surrounded by a sclerenchymatous bundle sheath. The ground tissue is not differentiated into cortex and pith but remains a conspicuous parenchymatous mass. Additionally, the vascular bundles are conjoint and closed, while phloem parenchyma is characteristically absent.

25. (3) Sapwood is the innermost secondary xylem and is lighter in colour.
Heartwood occupies the central region of a woody stem and consists of dead, lignified elements that provide mechanical support but do not conduct water. It is dark due to organic depositions. In contrast, sapwood is the peripheral region of secondary xylem that is lighter in color. It remains functionally active and is responsible for the upward conduction of water and minerals.

26. (1) both sieve tubes and companion cells
The phloem of gymnosperms is structurally different from that of angiosperms. While angiosperms possess sieve tube elements and companion cells, gymnosperms lack these specific components. Instead, they contain sieve cells for translocation and albuminous cells, which perform functions similar to companion cells. This anatomical distinction in the vascular tissue is a key characteristic used to differentiate between these two groups.

27. (3) intercalary meristem
Grasses possess specialized meristematic tissues located at the base of nodes and leaf blades, known as intercalary meristems. These tissues are primary meristems that remain separated from the apical meristem by mature tissues. When herbivores graze on the tops of grasses, the intercalary meristems facilitate the rapid regeneration of the removed parts. This adaptation allows grasses to thrive despite grazing.

28. (3) Flaccidity of bulliform cells
Bulliform cells are large, thin-walled epidermal cells found in grasses that respond to changes in water availability. When water is abundant, these cells absorb moisture and become turgid, keeping the leaf surface expanded. During dry weather, the loss of turgor pressure causes these cells to become flaccid. This change results in the leaf curling inwards, which significantly reduces the transpiration.

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nucleus to create a more efficient pathway for the flow of organic sap. Despite the absence of a nucleus, the cell remains living and contains cytoplasm. It relies on the associated companion cells to provide essential proteins and metabolic support needed.

105. (1) Cucurbita
Collenchyma is a simple living tissue that provides mechanical support to growing plant parts. Angular collenchyma is characterized by cellulose and pectin depositions that are concentrated at the corners of the cells where several cells meet. This specific type of tissue is commonly found in the stems and petioles of various dicotyledonous plants, with the stem of Cucurbita serving as a classic.

106. (3) climbing stems
Collenchyma is a specialized living tissue that provides both mechanical strength and flexibility to the plant. It is typically found in the peripheral regions of stems and petioles, especially in young organs. This tissue is particularly well-developed in climbing stems where it helps the plant withstand bending and tension. The thickened cell walls consist of cellulose and pectin, allowing for structural support.

107. (3) dicot herbs
Collenchyma is a primary supporting tissue that is characteristic of the stems and petioles of many dicotyledonous herbs. It is usually absent in monocots and is rarely found in roots. This living tissue consists of elongated cells with unevenly thickened walls, providing structural support while allowing flexibility. By being located beneath the epidermis, collenchyma helps young dicot stems and leaves maintain shape.

108. (3) lateral meristem
The cork cambium and vascular cambium are both types of lateral meristems found in woody plants. They are responsible for secondary growth, which increases the thickness of the plant body. The vascular cambium produces secondary xylem and phloem, while the cork cambium produces the periderm. Unlike apical meristems that cause elongation, lateral meristems are essential for the structural thickening and durability.

109. (2) lateral roots
The pericycle is a layer of cells located just inside the endodermis of the root. One of the most important functions of the pericycle in roots is the initiation of lateral roots. During this process, cells in the pericycle become meristematic and divide to form a new root primordium. Additionally, the pericycle contributes to the formation of the vascular cambium.

110. (1) intercalary meristem
Monocotyledonous leaves, such as those found in grasses, are characterized by the presence of intercalary meristems. These meristems are located at the base of the leaf blade and are responsible for elongation. This specialized tissue is a primary meristem that remains active after apical growth. Intercalary meristems allow grasses to rapidly regrow after being grazed, providing a significant advantage for survival.

111. (3) broader lumen and perforated cross walls
Sieve tube elements are highly efficient at translocating organic nutrients over long distances within the plant. Their effectiveness is due to structural adaptations. They possess a relatively broad lumen which minimizes resistance to the flow of sap. Furthermore, their end walls are perforated with numerous pores to form sieve plates. This allows for a continuous, tube-like system throughout the functional phloem tissue.

112. (1) transport of sap
For some essential plant functions, the death of the cell's protoplasm is a necessary developmental step. This is most evident in the xylem tissue, specifically in vessels and tracheids, which are responsible for the transport of sap. These cells must lose their living contents to become hollow conduits for the upward movement of water. This transformation ensures minimal resistance to the flow.

113. (3) Ring porous wood carries more water when need is higher.
In ring-porous wood, the vessels produced early in the growing season are significantly larger than those produced later. This specialized arrangement allows for a high capacity of water transport during the spring when the plant's metabolic and transpiration needs are at their peak. In contrast, diffuse-porous wood has vessels of more uniform size distributed throughout. Ring-porous wood meets high seasonal demands.

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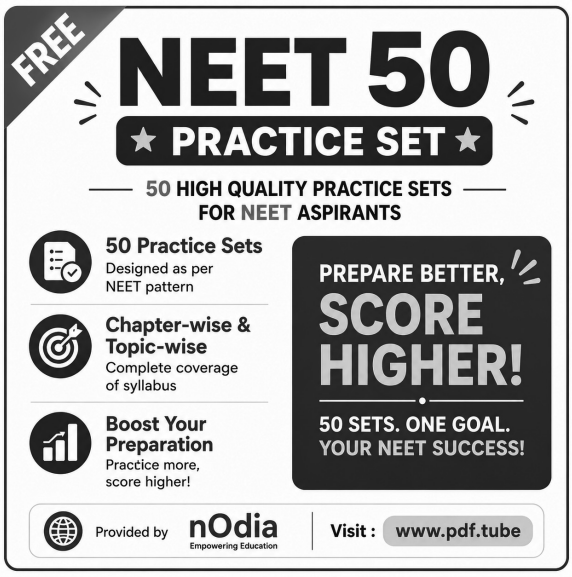
114. (1) planes of cell division
The tunica-corpus theory describes the organization of the shoot apical meristem into two distinct zones. The tunica consists of outer layers where cells divide primarily in an anticlinal plane. Beneath the tunica lies the corpus, where cells divide in various planes to increase the volume of the shoot. Therefore, the distinction between these regions is fundamentally determined by the planes of division.

115. (1) Lateral meristem
Increase in the girth of a plant is referred to as secondary growth and is mediated by lateral meristems. These include the vascular cambium and the cork cambium. Unlike apical and intercalary meristems which contribute to primary growth, lateral meristems divide in a radial fashion. This activity adds new layers of secondary tissues, which provide essential structural support to widening stems.

116. (3) shoot apex
The tunica-corpus theory is a major model used to explain the structural organization and developmental patterns of the shoot apex in angiosperms. It proposes that the apical meristem is divided into two regions based on the planes of cell division. The tunica increases surface area, while the inner mass, or corpus, increases volume. This theory helps explain how primary tissues initiate.

117. (1) monocot stem
In the anatomy of a monocotyledonous stem, the ground tissue is not clearly divided into distinct regions like the cortex and pith. Instead, it consists of a continuous mass of parenchymatous cells in which numerous vascular bundles are scattered. This is in contrast to dicotyledonous stems, where the ground tissue is organized into a definite peripheral cortex and a central pith.

118. (1) cork cambium (phellogen)
Cork, biologically known as phellem, is a protective tissue that forms on the outer surface of woody stems and roots during secondary growth. It is produced by the activity of the phellogen, also called the cork cambium. The phellogen is a lateral meristem that arises in the cortical layers. As phellem cells form, they become suberized and die, creating a waterproof barrier.



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CHAPTER 07
Structural Organisation in Animals

2025

1. In frog, the renal portal system is a special venous connection that acts to link
(1) kidney and intestine
(2) kidney and lower part of body
(3) liver and intestine
(4) liver and kidney.

2025

2. Frogs respire in water by skin and buccal cavity and on land by skin, buccal cavity and lungs. Choose the correct answer from the following:
(1) The statement is false for water but true for land
(2) The statement is false for both the environment
(3) The statement is true for water but false for land
(4) The statement is true for both the environment

2025

3. What is the name of the blood vessel that carries deoxygenated blood from the body to the heart in a frog?
(1) Pulmonary vein
(2) Vena cava
(3) Aorta
(4) Pulmonary artery

2025

4. Which of the following statement is correct about location of the male frog copulatory pad?
(1) Second digit of fore limb
(2) First digit of the fore limb
(3) First and second digit of fore limb
(4) First digit of hind limb

RE-EXAM 2024

5. Which of the following statements is correct about the type of junction and their role in our body?
(1) Adhering junctions facilitate the cells to communicate with each other.
(2) Tight junctions help to stop substances from leaking across a tissue.
(3) Tight junctions help to perform cementing to keep neighbouring cells together.
(4) Gap junctions help to create gap between the cells and tissues.

RE-EXAM 2024

6. In which of the following connective tissues, the cells secrete fibres of collagen or elastin?
A. Cartilage
B. Bone
C. Adipose tissue
D. Blood
E. Areolar tissue
Choose the most appropriate answer from the options given below.
(1) B, C, D and E only
(2) A, B, C and E only
(3) B, C and D only
(4) A, C and D only

RE-EXAM 2024

7. Match List-I with List-II.

	List-I		List-II
A.	Squamous epithelium	I.	Goblet cells of alimentary canal
B.	Ciliated epithelium	II.	Inner lining of pancreatic ducts
C.	Glandular epithelium	III.	Walls of blood vessels
D.	Compound epithelium	IV.	Inner surface of fallopian tubes

Choose the correct answer from the options given below.
(1) A-II, B-III, C-I, D-IV
(2) A-II, B-IV, C-III, D-I
(3) A-III, B-I, C-II, D-IV
(4) A-III, B-IV, C-I, D-II

2024

8. Three types of muscles are given as A, B, and C. Identify the correct matching pair along with their location in human body.

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NEET-I 2016

40. Which type of tissue correctly matches with its location?

	Tissue	Location
(1)	Transitional epithelium	Tip of nose
(2)	Cuboidal epithelium	Lining of stomach
(3)	Smooth muscle	Wall of intestine
(4)	Areolar tissue	Tendons

NEET-II 2016

41. In male cockroaches, sperms are stored in which part of the reproductive system?
(1) Seminal vesicles
(2) Mushroom glands
(3) Testes
(4) Vas deferens

NEET-I 2016

42. Which of the following features is not present in Periplaneta americana?
(1) Exoskeleton composed of N-acetylglucosamine
(2) Metamerically segmented body
(3) Schizocoelom as body cavity
(4) Indeterminate and radial cleavage during embryonic development

2015

43. The function of the gap junction is to
(1) separate two cells from each other
(2) stop substance from leaking across a tissue
(3) performing cementing to keep neighbouring cells together
(4) facilitate communication between adjoining cells by connecting the cytoplasm for rapid transfer of ions, small molecules and some large molecules.

2015

44. The body cells in cockroach discharge their nitrogenous waste in the haemolymph mainly in the form of
(1) urea
(2) calcium carbonate
(3) ammonia
(4) potassium urate.

2015 Cancelled

45. The terga, sterna and pleura of cockroach body are joined by
(1) arthrodial membrane
(2) cartilage
(3) cementing glue
(4) muscular tissue.

2014

46. Choose the correctly matched pair.
(1) Tendon - Specialized connective tissue
(2) Adipose tissue - Dense connective tissue
(3) Areolar tissue - Loose connective tissue
(4) Cartilage - Loose connective tissue

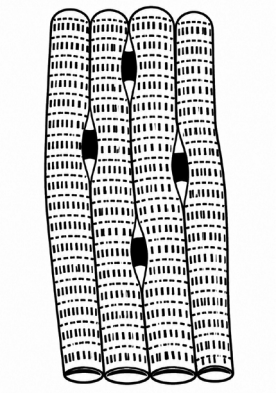
2014

47. Choose the correctly matched pair.
(1) Inner lining of salivary ducts - Ciliated epithelium
(2) Moist surface of buccal cavity - Glandular epithelium
(3) Tubular parts of nephrons - Cuboidal epithelium
(4) Inner surface of bronchioles - Squamous epithelium

NODIA

Karnataka NEET 2013

48. Identify the tissue shown in the diagram and match with its characteristics and its location.



(1) Smooth muscles, show branching, found in the wall of the heart
(2) Cardiac muscles, unbranched muscles, found in the walls of the heart
(3) Striated muscles, tapering at both ends, attached with the bones of the ribs
(4) Skeletal muscles show striations and are closely attached with the bones of the limbs

2013

49. What external changes are visible after the last moult of a cockroach nymph?
(1) Both forewings and hindwings develop
(2) Labium develops
(3) Mandibles become harder
(4) Anal cerci develop

Choose the correct answer from the options given below :
(1) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)
(2) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)
(3) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
(4) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

Manipur NEET 2023

14. Given below are two statements.
Statement I : Goblet cells are unicellular glands.
Statement II : Earwax is the secretion of exocrine gland.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

2023

15. Given below are two statements:
Statement I: Ligaments are dense irregular tissue.
Statement II: Cartilage is dense regular tissue.
In the light of the above statements, choose the correct answer from the options given below:
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

2023

16. Match List I with List II.

	List-I		List-II
A.	Mast cells	I.	Ciliated epithelium
B.	Inner surface of bronchiole	II.	Areolar connective tissue
C.	Blood	III.	Cuboidal epithelium
D.	Tubular parts of nephron	IV.	Specialised connective tissue

Choose the correct answer from the options give below:
(1) A-II, B-I, C-IV, D-III
(2) A-III, B-IV, C-II, D-I
(3) A-I, B-II, C-IV, D-III
(4) A-II, B-III, C-I, D-IV

Manipur NEET 2023

17. Given below are two statements.
Statement I : In cockroach, the forewings are transparent and prothoracic in origin.
Statement II : In cockroach, the hind wings are opaque, leathery and mesothoracic in origin.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is correct but statement II is false.
(2) Statement I is incorrect but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

Manipur NEET 2023

18. The cockroach is
(1) ammonotelic only
(2) uricotelic only
(3) ureotelic only
(4) ureotelic and uricotelic.

2023

19. Match List I with List II.

	List-I		List-II
A.	Taenia	I.	Nephridia
B.	Paramecium	II.	Contractile vacuole
C.	Periplaneta	III.	Flame cells
D.	Pheretima	IV.	Urecose gland

Choose the correct answer from the options give below:
(1) A-III, B-II, C-IV, D-I
(2) A-II, B-I, C-IV, D-III
(3) A-I, B-II, C-III, D-IV
(4) A-I, B-II, C-IV, D-III

2023

20. Which of the following is characteristic feature of cockroach regarding sexual dimorphism?
(1) Presence of sclerites
(2) Presence of anal cerci
(3) Dark brown body colour and anal cerci
(4) Presence of anal styles

2023

21. In cockroach, excretion is brought about by
A. Phallic gland
B. Urecose gland
C. Nephrocytes
D. Fat body
E. Collaterial glands.
Choose the correct answer from the options given below:
(1) B, C and D only
(2) B and D only
(3) A and E only
(4) A, B and E only

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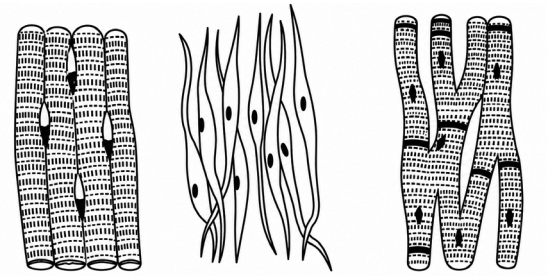

	Name of Muscle		Location
(1)	(A) Smooth	-	Toes
	(B) Skeletal	-	Legs
	(C) Cardiac	-	Heart
(2)	(A) Skeletal	-	Triceps
	(B) Smooth	-	Stomach
	(C) Cardiac	-	Heart
(3)	(A) Skeletal	-	Biceps
	(B) Involuntary	-	Intestine
	(C) Cardiac	-	Heart
(4)	(A) Involuntary	-	Nose tip
	(B) Skeletal	-	Bone
	(C) Cardiac	-	Heart

2024

9. Match List I with List II.

	List-I		List-II
A.	Unicellular glandular epithelium	I.	Salivary glands
B.	Compound epithelium	II.	Pancreas
C.	Multicellular glandular epithelium	III.	Goblet cells of alimentary canal
D.	Endocrine glandular epithelium	IV.	Moist surface of buccal cavity

Choose the correct answer from the options given below.
(1) A-II, B-I, C-III, D-IV
(2) A-IV, B-III, C-I, D-II
(3) A-III, B-IV, C-I, D-II
(4) A-II, B-I, C-IV, D-III

RE-EXAM 2024

10. Which of the following is/are present in female cockroach?
A. Collaterial gland
B. Mushroom gland
C. Spermatheca
D. Anal style
E. Phallic gland
Choose the most appropriate answer from the options given below.
(1) B and D only
(2) B and E only
(3) A only
(4) A and C only

NODIA

2024

11. In both sexes of cockroach, a pair of jointed filamentous structures called anal cerci are present on
(1) 5th segment
(2) 10th segment
(3) 8th and 9th segment
(4) 11th segment.

2024

12. Match List I with List II related to digestive system of cockroach.

	List-I		List-II
A.	The structures used for storing of food.	I.	Gizzard
B.	Ring of 6-8 blind tubules at junction of foregut and midgut.	II.	Gastric caeca
C.	Ring of 100-150 yellow coloured thin filaments at junction of midgut and hindgut	III.	Malpighian tubules
D.	The structures used for grinding the food.	IV.	Crop

Choose the correct answer from the options given below.
(1) A-IV, B-II, C-III, D-I
(2) A-I, B-II, C-III, D-IV
(3) A-IV, B-III, C-II, D-I
(4) A-III, B-II, C-IV, D-I

Manipur NEET 2023

13. Match List I with List II.

	List I		List II
(A)	Columnar epithelium	(i)	Ducts of glands
(B)	Ciliated epithelium	(ii)	Inner lining of stomach and intestine
(C)	Squamous epithelium	(iii)	Inner lining of bronchioles
(D)	Cuboidal epithelium	(iv)	Endothelium

2020

32. If the head of cockroach is removed, it may live for few days because
(1) the supra-oesophageal ganglia of the cockroach are situated in ventral part of abdomen
(2) the cockroach does not have nervous system
(3) the head holds a small proportion of a nervous system while the rest is situated along the ventral part of its body
(4) the head holds a 1/3rd of a nervous system while the rest is situated along the dorsal part of its body.

2019

33. The ciliated epithelial cells are required to move particles or mucus in a specific direction. In humans, these cells are mainly present in
(1) bronchioles and fallopian tubes
(2) bile duct and bronchioles
(3) Fallopian tubes and pancreatic duct
(4) Eustachian tube and salivary duct.

Odisha NEET 2019

34. Match the following cell structure with its characteristic feature.

List-I (Cell Structure)		List-II (Characteristic Feature)	
(A)	Tight junctions	(i)	Cement neighbouring cells together to form sheet
(B)	Adhering junctions	(ii)	Transmit information through chemical to another cells
(C)	Gap junctions	(iii)	Establish a barrier to prevent leakage of fluid across epithelial cells
(D)	Synaptic junctions	(iv)	Cytoplasmic channels to facilitate communication between adjacent cells

Select correct option from the following.
(1) (A)-(ii), (B)-(i), (C)-(iii), (D)-(iv)
(2) (A)-(iv), (B)-(ii), (C)-(i), (D)-(iii)
(3) (A)-(iii), (B)-(i), (C)-(iv), (D)-(ii)
(4) (A)-(iv), (B)-(iii), (C)-(i), (D)-(ii)

2019

35. Select the correct sequence of organs in the alimentary canal of cockroach starting from mouth.
(1) Pharynx → Oesophagus → Ileum → Crop → Gizzard → Colon → Rectum
(2) Pharynx → Oesophagus → Crop → Gizzard → Ileum → Colon → Rectum
(3) Pharynx → Oesophagus → Gizzard → Crop → Ileum → Colon → Rectum
(4) Pharynx → Oesophagus → Gizzard → Ileum → Crop → Colon → Rectum

2018

36. Which of the following features is used to identify a male cockroach from a female cockroach?
(1) Presence of a boat-shaped sternum on the 9th abdominal segment
(2) Presence of caudal styles
(3) Forewings with darker tegmina
(4) Presence of anal cerci

2017

37. Select the correct route for the passage of sperms in male frogs.
(1) Testes → Vasa efferentia → Kidney → Seminal vesicle → Urinogenital duct → Cloaca
(2) Testes → Vasa efferentia → Bidder's canal → Ureter → Cloaca
(3) Testes → Vasa efferentia → Kidney → Bidder's canal → Urinogenital duct → Cloaca
(4) Testes → Bidder's canal → Kidney → Vasa efferentia → Urinogenital duct → Cloaca

2017

38. Frog's heart when taken out of the body continues to beat for sometime.
Select the best option from the following statements.
(1) Frog is a poikilotherm.
(2) Frog does not have any coronary circulation.
(3) Heart is "myogenic" in nature.
(4) Heart is autoexcitable.
(1) Only (4)
(2) (1) and (2)
(3) (3) and (4)
(4) Only (3)

NEET-II 2016

39. Smooth muscles are
(1) involuntary, fusiform, non-striated
(2) voluntary, multinucleate, cylindrical
(3) involuntary, cylindrical, striated
(4) voluntary, spindle-shaped, uninucleate.

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2012

56. Select the correct statement from the ones given below with respect to Periplaneta americana.
(1) Nervous system located dorsally, consists of segmentally arranged ganglia joined by a pair of longitudinal connectives.
(2) Males bear a pair of short thread like anal styles.
(3) There are 16 very long Malpighian tubules present at the junctions of midgut and hindgut.
(4) Grinding of food is carried out only by the mouth parts.

2012

57. Compared to those of humans, the erythrocytes in frog are
(1) without nucleus but with haemoglobin
(2) nucleated and with haemoglobin
(3) very much smaller and fewer
(4) nucleated and without haemoglobin.

2011

58. The ciliated columnar epithelial cells in humans are known to occur in
(1) Eustachian tube and stomach lining
(2) bronchioles and Fallopian tube
(3) bile duct and oesophagus
(4) Fallopian tube and urethra.

Mains 2011, 2010

59. The cells lining the blood vessels belong to the category of
(1) smooth muscle tissue
(2) squamous epithelium
(3) columnar epithelium
(4) connective tissue.

2011

60. One very special feature in the earthworm (Pheretima) is that
(1) fertilization of eggs occurs inside the body
(2) the typhlosole greatly increases the effective absorption area of the digested food in the intestine
(3) the S-shaped setae embedded in the integument are the defensive weapons used against the enemies
(4) it has a long dorsal tubular heart.

Mains 2011

61. Which one of the following structures in Pheretima is correctly matched with its function?
(1) Clitellum - Secretes cocoon
(2) Gizzard - Absorbs digested food
(3) Setae - Defence against predators
(4) Typhlosole - Storage of extra nutrients

2011

62. Which of the following happens in the common cockroach?
(1) Malpighian tubules are excretory organs projecting out from the colon.
(2) Oxygen is transported by haemoglobin in blood.
(3) Nitrogenous excretory product is urea.
(4) The food is ground by mandibles and gizzard.

NODIA

Mains 2011

63. Frogs differ from humans in possessing
(1) paired cerebral hemispheres
(2) hepatic portal system
(3) nucleated red blood cells
(4) thyroid as well as parathyroid.

Mains 2011

64. Ureters act as urinogenital ducts in
(1) human males
(2) human females
(3) both male and female frogs
(4) male frogs.

Mains 2011

65. Consider the following four statements (A-D) related to the common frog Rana tigrina, and select the correct option stating which ones are true (T) and which ones are false (F).
Statements:
A. On dry land it would die due to lack of O_2 if its mouth is forcibly kept closed for a few days.
B. It has four-chambered heart.
C. On dry land it turns uricotelic from ureotelic.
D. Its life-history is carried out in pond water.
(1) A-T; B-F; C-F; D-T
(2) A-T; B-T; C-F; D-F
(3) A-F; B-F; C-T; D-T
(4) A-F; B-T; C-T; D-F

2009

66. Which one of the following is correct pairing of a body part and the kind of muscle tissue that moves it?
(1) Biceps of upper arm - Smooth muscle fibres
(2) Abdominal wall - Smooth muscle
(3) Iris - Involuntary smooth muscle
(4) Heart wall - Involuntary unstriated muscle

Karnataka NEET 2013

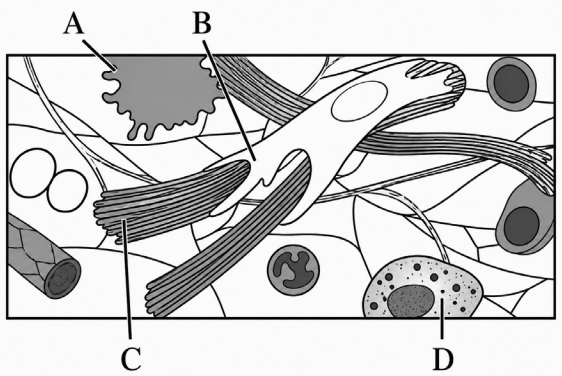
50. Select the correct option with respect to cockroaches.
(1) Malpighian tubules convert nitrogenous wastes into urea.
(2) Males bear short anal styles not present in females.
(3) Nervous system comprises of a dorsal nerve cord and ten pairs of ganglia.
(4) The forewings are tegmina which are used in flight.

Karnataka NEET 2013

51. Which one of the following is one of the paths followed by air or O_2 during respiration in the adult male Periplaneta americana as it enters the animal body?
(1) Spiracle in metathorax, trachea, tracheoles, oxygen diffuses into cells
(2) Mouth, bronchial tube, trachea, oxygen enters cells
(3) Spiracles in prothorax, tracheoles, trachea, oxygen diffuses into cells
(4) Hypopharynx, mouth, pharynx, trachea, tissues

Mains 2012

52. Given below is the diagrammatic sketch of a certain type of connective tissue. Identify the parts labelled A, B, C and D and select the right option about them.



(1) A-Macrophage; B-Fibroblast; C-Collagen fibres; D-Mast cell
(2) A-Mast cell; B-Macrophage; C-Fibroblast; D-Collagen fibres
(3) A-Macrophage; B-Collagen fibres; C-Fibroblast; D-Mast cell
(4) A-Mast cell; B-Collagen fibres; C-Fibroblast; D-Macrophage

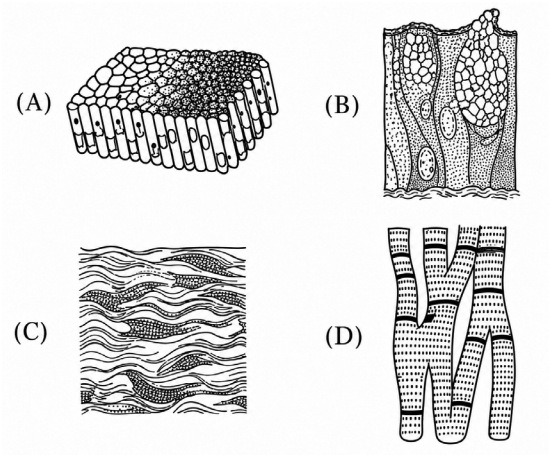
NODIA

Mains 2012

53. The supportive skeletal structures in the human external ears and in the nose tip are examples of
(1) ligament
(2) areolar tissue
(3) bone
(4) cartilage.

Mains 2012

54. The four sketches (A, B, C and D) given below, represent four different types of animal tissues. Which one of these is correctly identified in the options given, along with its correct location and function?



		Tissue	Location	Function
(1)	(B)	Glandular epithelium	Intestine	Secretion
(2)	(C)	Collagen fibres	Cartilage	Attach skeletal muscles to bones
(3)	(D)	Smooth muscle tissue	Heart	Heart contraction
(4)	(A)	Columnar epithelium	Nephron	Secretion and absorption

2012

55. Pheretima and its close relatives derive nourishment from
(1) sugarcane roots
(2) decaying fallen leaves and soil organic matter
(3) soil insects
(4) small pieces of flesh fallen leaves of maize, etc.

2022

22. Which of the following is not a connective tissue?
(1) Blood
(2) Adipose tissue
(3) Cartilage
(4) Neuroglia

2022

23. Which of the following is present between the adjacent bones of the vertebral column ?
(1) Intercalated discs
(2) Cartilage
(3) Areolar tissue
(4) Smooth muscle

2022

24. Match list-I with list-II.

	List I		List II
(A)	Bronchioles	(i)	Dense regular connective tissue
(B)	Goblet cell	(ii)	Loose connective tissue
(C)	Tendons	(iii)	Glandular tissue
(D)	Adipose Tissue	(iv)	Ciliated epithelium

Choose the correct answer from the option given below :
(1) (A)-(iv), (B)-(iii), (C)-(i), (D)-(ii)
(2) (A)-(i), (B)-(ii), (C)-(iii), (D)-(iv)
(3) (A)-(ii), (B)-(i), (C)-(iv), (D)-(iii)
(4) (A)-(iii), (B)-(iv), (C)-(ii), (D)-(i)

2022

25. Tegmina in cockroach, arises from
(1) prothorax
(2) mesothorax
(3) metathorax
(4) prothorax and mesothorax.

2021

26. Which of the following statements wrongly represents the nature of smooth muscle?
(1) These muscles are present in the wall of blood vessels.
(2) These muscle have no striations.
(3) They are involuntary muscles.
(4) Communication among the cells is performed by intercalated discs.

2021

27. Identify the types of cell junctions that help to stop the leakage of the substances across a tissue and facilitation of communication with neighbouring cells via rapid transfer of ions and molecules.
(1) Adhering junctions and gap junctions, respectively.
(2) Gap junctions and adhering junctions, respectively.
(3) Tight junctions and gap junctions, respectively.
(4) Adhering junctions and tight junctions, respectively.

2021

28. Following are the statements about prostomium of earthworm.
(A) It serves as a covering for mouth.
(B) It helps to open cracks in the soil into which it can crawl.
(C) It is one of the sensory structures.
(D) It is the first body segment.
Choose the correct answer from the options given below.
(1) (B) and (C) are correct.
(2) (A), (B) and (C) are correct.
(3) (A), (B) and (D) are correct.
(4) (A), (B), (C) and (D) are correct.

2021

29. Which of the following characteristics is incorrect with respect to cockroach?
(1) 10th abdominal segment in both sexes, bears a pair of anal cerci.
(2) A ring of gastric caeca is present at the junction of midgut and hind gut.
(3) Hypopharynx lies within the cavity enclosed by the mouth parts.
(4) In females, 7th-9th sterna together form a genital pouch.

2020

30. Cuboidal epithelium with brush border of microvilli is found in
(1) lining of intestine
(2) ducts of salivary glands
(3) proximal convoluted tubule of nephron
(4) Eustachian tube.

2020

31. Goblet cells of alimentary canal are modified from
(1) squamous epithelial cells
(2) columnar epithelial cells
(3) chondrocytes
(4) compound epithelial cells.

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2009

67. The epithelial tissue present on the inner surface of bronchioles and fallopian tubes is
(1) glandular
(2) ciliated
(3) squamous
(4) cuboidal.

2009

68. The cell junctions called tight, adhering and gap junctions are found in
(1) connective tissue
(2) epithelial tissue
(3) neural tissue
(4) muscular tissue.

2009

69. The kind of tissue that forms the supportive structure in our pinna (external ears) is also found in
(1) nails
(2) ear ossicles
(3) tip of the nose
(4) vertebrae.

2009

70. Which one of the following correctly describes the location of some body parts in the earthworm Pheretima?
(1) Four pairs of spermathecae in 4th-7th segments
(2) One pair of ovaries attached at intersegmental septum of 14th and 15th segments
(3) Two pairs of testes in 10th and 11th segments
(4) Two pairs of accessory glands in 16th-18th segments

2009

71. If a live earthworm is pricked with a needle on its outer surface without damaging its gut, the fluid that comes out is
(1) coelomic fluid
(2) haemolymph
(3) slimy mucus
(4) excretory fluid.

2008

72. Earthworms have no skeleton but during burrowing, the anterior end becomes turgid and acts as a hydraulic skeleton. It is due to
(1) gut peristalsis
(2) setae
(3) coelomic fluid
(4) blood.

NODIA

2008

73. Which one of the following is the true description about an animal concerned?
(1) Rat - Left kidney is slightly higher in position than the right one
(2) Cockroach - 10 pairs of spiracles (2 pairs on thorax and 8 pairs on abdomen)
(3) Earthworm - The alimentary canal consists of a sequence of pharynx, oesophagus, stomach, gizzard and intestine
(4) Frog - Body divisible into three regions - head, neck and trunk

2007

74. Which one of the following pairs of structures distinguishes a nerve cell from other types of cell?
(1) Vacuoles and fibres
(2) Flagellum and medullary sheath
(3) Nucleus and mitochondria
(4) Perikaryon and dndrites

2007

75. In which one of the following preparations are you likely to come across cell junctions most frequently?
(1) Thrombocytes
(2) Tendon
(3) Hyaline cartilage
(4) Ciliated epithelium

2006

76. Areolar connective tissue joins
(1) bones with bones
(2) fat body with muscles
(3) integument with muscles
(4) bones with muscles.

2006

77. Mast cells secrete
(1) haemoglobin
(2) hippurin
(3) myoglobin
(4) histamine.

2006

78. Earthworms are
(1) ammonotelic when plenty of water is available
(2) ureotelic when plenty of water is available
(3) uricotelic when plenty of water is available
(4) uricotelic under conditions of water scarcity.

2005

79. Four healthy people in their twenties got involved in injuries resulting in damage and death of few cells of the following. Which of the cells are least likely to be replaced by new cells?
(1) liver cells
(2) Neurons
(3) Malpighian layer of the skin
(4) Osteocytes

2004

80. Mast cells of connective tissue contain
(1) vasopressin and relaxin
(2) heparin and histamine
(3) heparin and calcitonin
(4) serotonin and melanin.

2003

81. Which one of the following contains the largest quantity of extracellular material ?
(1) Striated muscle
(2) Areolar tissue
(3) Stratified epithelium
(4) Myelinated nerve fibres

2002

82. Collagen is
(1) fibrous protein
(2) globular protein
(3) lipid
(4) carbohydrate.

2001

83. During an injury nasal septum gets damaged and for its recovery which cartilage is preferred?
(1) Elastic cartilage
(2) Hyaline cartilage
(3) Calcified cartilage
(4) Fibrous cartilage

2001

84. Which cells do not form layer and remains structurally separate?
(1) Epithelial cells
(2) Muscle cells
(3) Nerve cells
(4) Gland cells

2000

85. Proteoglycan in cartilages which is a part of polysaccharide is
(1) chondroitin
(2) ossein
(3) casein
(4) cartilagin.

2000

86. Characteristic of simple epithelium is that they
(1) are arranged indiscriminately
(2) make a definite layer
(3) continue to divide and help in organ function
(4) none of the above.

2000

87. Primary function of enteronephric nephridia of Pheretima is
(1) osmoregulation
(2) excretion of nitrogenous wastes
(3) respiration
(4) locomotion.

2000

88. What happens if bone of frog is kept in dilute hydrochloric acid?
(1) Will become flexible
(2) Will turn black
(3) Will break into pieces
(4) Will shrink

1999

89. Ligament is a/an
(1) inelastic white fibrous tissue
(2) modified white fibrous tissue
(3) modified yellow elastic fibrous tissue
(4) none of the above.

1999

90. Tendon is made up of
(1) yellow fibrous connective tissue
(2) modified white fibrous tissue
(3) areolar tissue
(4) adipose tissue.

1998

91. In mammals, histamine is secreted by
(1) lymphocytes
(2) mast cells
(3) fibroblasts
(4) histiocytes.

1997

92. Protein present in cartilage is
(1) cartilagin
(2) ossein
(3) chondrin
(4) none of these.

1997

93. Basement membrane is made up of
(1) no cell product of epithelial cell
(2) epidermal cell only
(3) endodermal cell
(4) both (b) and (c).

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1997

94. Stratum germinativum is an example of which kind of epithelium?
(1) Columnar
(2) Squamous
(3) Cuboidal
(4) Ciliated

1997

95. The roof of the cranium of frog is formed by
(1) frontoparietal
(2) orbitosphenoid
(3) parasphenoid
(4) alisphenoid.

1997

96. In frog, the surface of attachment of tongue is
(1) pterygoid
(2) hyoid apparatus
(3) parasphenoid
(4) palatine.

1997

97. In frog, "fenestra ovalis" is
(1) the communication between the pharynx and the tympanic cavity
(2) the external opening of the tympanic cavity which is covered by the tympanic membrane
(3) the air filled cavity of the middle ear
(4) the opening in the auditory capsule which separates the middle ear from the internal ear.

1997

98. The kidney of an adult frog is
(1) metanephros
(2) opisthonephros
(3) pronephros
(4) mesonephros.

1994

99. An epithelial tissue which has thin flat cells, arranged edge to edge so as to appear like closely packed tiles, is found to be present at
(1) outer surface of ovary
(2) inner lining of Fallopian tube
(3) inner lining of stomach
(4) inner lining of cheeks.

1993

100. Hair present in the skin are
(1) epidermal in origin and made of dead cells
(2) epidermal in origin and made of living cells
(3) dermal in origin and made of living cells
(4) dermal in origin and made of dead cells.

1993

101. The layer of actively dividing cells of skin is termed as
(1) stratum compactum
(2) stratum corneum
(3) stratum malpighii/stratum germinativum
(4) stratum lucidum.

1993

102. Formation of cartilage bones involves
(1) deposition of bony matter by osteoblasts and resorption by chondroclasts
(2) deposition of bony matter by osteoclasts
(3) deposition of bony matter by osteoclasts only
(4) deposition of bony matter by osteoblasts only.

1993

103. Mucus helps frog in forming
(1) thick skin
(2) dry skin
(3) smooth skin
(4) moist skin.

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1992

104. Characteristics of smooth muscle fibres are
(1) spindle-shaped, unbranched, nonstriated, uninucleate and involuntary
(2) spindle-shaped, unbranched, unstriped, multinucleate and involuntary
(3) cylindrical, unbranched, unstriped, multinucleate and involuntary
(4) cylindrical, unbranched, striated, multinucleate and voluntary.

1992

105. Assertion (A) : Periplaneta americana is nocturnal, omnivorous, household pest.
Reason (R) : It is because it acts as scavenger.
(1) A is true but R is false.
(2) A is false but R is true.
(3) Both A and R are true and R is correct explanation of A.
(4) Both A and R are true but R is not correct explanation of A.

1992

106. Bullfrog of India is
(1) Rana tigrina
(2) R. sylvatica
(3) R. catesbeiana
(4) R. esculenta.

Communication in smooth muscle typically occurs through gap junctions, which allow for coordinated movement.

Muscle types are distinguished by their microscopic structure and physiological control. Smooth muscle is specialized for slow, sustained contractions in the viscera. Skeletal muscle is voluntary and striated for movement. Cardiac muscle is unique for its continuous rhythmic activity and specialized cell-to-cell junctions like intercalated discs. Knowing these differences is vital for understanding how different organs and systems function and communicate.

27. (3) Tight junctions and gap junctions, respectively.
Tight junctions function as a seal between adjacent cells, preventing the leakage of substances across tissue layers. Gap junctions act as communication channels, allowing the rapid transfer of ions, small molecules, and sometimes larger molecules between neighboring cells. These specialized structures are essential for maintaining tissue integrity and coordinating cellular activities. Adhering junctions, meanwhile, serve to cement neighboring cells together firmly.

Cell junctions are critical for the formation and function of tissues. Tight junctions ensure that materials pass through cells rather than between them, maintaining specialized environments. Gap junctions provide a pathway for electrical and chemical signals to move quickly between cells, which is vital for tissue coordination. Understanding these roles is fundamental to histology and cell biology, explaining how cells work together effectively.

28. (2) (A), (B) and (C) are correct.
The prostomium is a small, lobe-like structure at the anterior end of the earthworm. It acts as a wedge to force open cracks in the soil, serves as a protective covering for the mouth, and contains sensory receptors for environmental detection. However, it is not considered the first body segment; the peristomium is the actual first segment that contains the mouth.

Understanding earthworm anatomy involves distinguishing between sensory and structural parts. The prostomium is functionally important for burrowing and sensation but remains pre-segmental. The segments of the body, starting with the peristomium, make up the rest of the worm. This distinction is vital for accurately describing the morphology and behavior of these annelids in their natural soil environments during locomotion.

29. (2) A ring of gastric caeca is present at the junction of midgut and hind gut.
Gastric caeca are a ring of 6 to 8 blind tubules located at the junction of the female and male genital system? No, in cockroaches, they are at the junction of the foregut and midgut, where they secrete digestive enzymes. The junction of the midgut and hindgut is actually where the Malpighian tubules are situated. Other features, such as the 10th segment anal cerci and the female genital pouch, are correctly described for cockroaches.

Accurate knowledge of the digestive and reproductive anatomy is essential for studying insect biology. Gastric caeca and Malpighian tubules are placed at specific junctions to perform their respective digestive and excretory functions. Misidentifying these locations leads to an incorrect understanding of physiological processes. Proper identification of these structures is key to understanding how cockroaches manage digestion and waste removal internally.

30. (3) proximal convoluted tubule of nephron
The proximal convoluted tubule of the nephron is lined with simple cuboidal epithelium featuring a brush border of microvilli. This specialized structure significantly increases the surface area available for the reabsorption of water, ions, and nutrients from the glomerular filtrate back into the bloodstream. While the intestine also has microvilli, it is lined with columnar cells rather than the cuboidal type.

Epithelial adaptations are critical for organ function. In the kidney, the need for extensive reabsorption is met by the increased surface area provided by microvilli on cuboidal cells. This allows the nephron to efficiently process large volumes of filtrate. Other locations mentioned, like salivary ducts or Eustachian tubes, have different epithelial linings suited to their specific secretory or protective requirements.

31. (2) columnar epithelial cells
Goblet cells are specialized unicellular glands that are modified from simple columnar epithelial cells. They are found interspersed within the lining of the respiratory and digestive tracts. Their primary function is to synthesize and secrete mucus, which protects the epithelial surface and lubricates the passage of materials.

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ANSWERS

1. (2) kidney and lower part of body

The renal portal system in frogs is a specialized venous network that collects blood from the lower parts of the body, such as the hind limbs. This venous blood is then transported directly to the kidneys before it returns to the heart. It ensures efficient processing of metabolic wastes from the posterior extremities through renal filtration.

This system is characteristic of amphibians and provides a direct route for blood from the lower extremities to reach the renal tissues. This physiological arrangement helps in maintaining the internal balance by filtering nitrogenous wastes efficiently from the systemic circulation before the blood is re-oxygenated and redistributed by the heart.

2. (1) The statement is false for water but true for land

In aquatic environments, frogs primarily utilize their highly vascularized skin for cutaneous respiration to exchange gases. While on land, they employ a combination of buccal respiration, pulmonary respiration via the lungs, and continued cutaneous respiration through the skin. Buccal cavity gas exchange does not occur while the frog is submerged underwater during its aquatic phase, making the statement partially incorrect.

Frogs are versatile breathers adapted to both aquatic and terrestrial life. In water, the skin acts as the main respiratory organ because it is thin and moist. On land, the buccal cavity and lungs become active components of the respiratory system, alongside the skin, allowing the frog to transition between different environments while maintaining necessary oxygen levels.

3. (2) Vena cava

The vena cava serves as the primary large vessel responsible for returning deoxygenated blood from various systemic tissues and organs to the sinus venosus of the frog heart. It consists of the anterior and posterior vena cavae. This ensures that blood lacking oxygen is properly channeled back into the circulatory system to be re-oxygenated via the lungs and skin.

In the frog's circulatory system, the sinus venosus receives deoxygenated blood from the major veins known as vena cavae. This blood is then pumped into the right atrium. This process is vital for the continuous flow of blood, allowing the animal to sustain its metabolic activities by effectively recycling blood through the respiratory organs for gas exchange.

4. (2) First digit of the fore limb

Male frogs possess a specialized structure known as the copulatory pad, which is located on the first digit of each forelimb. This anatomical feature is seasonally developed and plays a crucial role during amplexus. It assists the male in firmly gripping the female, ensuring successful external fertilization of the eggs during the breeding season in their aquatic habitats.

These nuptial pads are secondary sexual characteristics that help in identifying the sex of the frog externally. During the mating season, these pads become more prominent due to hormonal changes. They provide the necessary friction for the male to hold onto the slippery skin of the female, which is essential for the synchronized release of gametes into water.

5. (2) Tight junctions help to stop substances from leaking across a tissue.

Tight junctions are specialized intercellular connections that seal the plasma membranes of adjacent epithelial cells together. This creates a nearly impermeable barrier that prevents the leakage of fluids and solutes across the tissue layer. Such structures are essential in maintaining the integrity of various bodily compartments and regulating the movement of substances between cells and the external environment.

Other types of junctions serve different purposes in cellular architecture. Adhering junctions provide mechanical stability by cementing neighboring cells together, while gap junctions facilitate direct communication through cytoplasmic channels for the rapid transfer of ions. Understanding these specific roles is fundamental to comprehending how tissues function as cohesive units and maintain homeostasis in complex biological systems.

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6. (2) A, B, C and E only

Cartilage, bone, adipose, and areolar tissues contain specialized cells like fibroblasts, chondrocytes, or osteocytes that synthesize and secrete structural proteins. These proteins include collagen and elastin, which provide strength and flexibility to the extracellular matrix. Blood is the exception among connective tissues because its plasma consists of proteins that are not secreted as fibers by the circulating cells.

Connective tissues are characterized by cells embedded in an extracellular matrix. In most cases, these cells are responsible for producing the fibers that define the physical properties of the tissue. Whether providing rigid support in bones or cushioning in adipose tissue, these secreted fibers are vital. Blood, being a fluid connective tissue, lacks these structural fibers in its normal state.

7. (4) A-III, B-IV, C-I, D-II

Squamous epithelium consists of thin, flat cells found in blood vessel walls. Ciliated epithelium moves particles in the fallopian tubes. Glandular epithelium, composed of specialized cells like goblet cells, facilitates secretion in the alimentary canal. Compound epithelium, made of multiple layers, provides protection and is found in structures like the inner lining of pancreatic ducts and the skin.

Each type of epithelial tissue is adapted to its specific functional role in the body. Squamous cells allow for efficient diffusion, while cilia provide movement for transported materials. Glandular cells are specialized for the synthesis and release of substances, and the multi-layered compound epithelium is designed to withstand mechanical stress and protect the underlying tissues from abrasion and chemical damage.

8. (2) (A) Skeletal - Triceps (B) Smooth - Stomach (C) Cardiac - Heart

Skeletal muscles, like the triceps, are voluntary and striated, facilitating movement of the limbs. Smooth muscles are involuntary and non-striated, found within the walls of internal organs such as the stomach. Cardiac muscles are unique, branched, and involuntary fibers located exclusively in the heart wall. These muscles ensure rhythmic contractions necessary for blood circulation throughout the human body.

Muscle tissues are categorized based on their appearance and control mechanisms. Skeletal muscle is under conscious control and attached to bones. Smooth muscle manages internal processes without conscious effort, such as digestion. Cardiac muscle is specialized for the heart's endurance and continuous operation. This diversity allows for a wide range of biological functions, from locomotion to vital organ maintenance.

9. (3) A-III, B-IV, C-I, D-II

Unicellular glands consist of isolated cells like goblet cells in the gut. Compound epithelium provides protection on moist surfaces like the buccal cavity. Multicellular glands include organized structures like salivary glands. Endocrine glands, such as the islets of Langerhans in the pancreas, secrete hormones directly into the bloodstream. These different epithelial types are specialized for secretion, protection, and regulation.

Glandular and protective epithelia are organized according to their complexity and function. While unicellular glands operate independently, multicellular glands form complex duct systems. Endocrine glands are ductless, releasing products into the circulatory system for distant effects. Compound epithelia offer robust defense in areas prone to wear. This structural variety ensures that all physiological requirements for secretion and protection are met.

10. (4) A and C only

The female reproductive system of a cockroach includes specific structures such as the collateral glands and spermatheca. Collateral glands secrete the material that forms the ootheca or egg case. Spermathecae are used for storing sperm received during mating. In contrast, mushroom glands and phallic glands are male reproductive organs, while anal styles are also unique to the males.

Identifying the components of the reproductive system is essential for distinguishing between sexes in cockroaches. Collateral glands play a vital role in protecting developing embryos within the ootheca. Spermathecae allow females to fertilize eggs over time. Male-specific structures like the mushroom gland and anal styles are involved in sperm production and mating, highlighting the significant sexual dimorphism in these insects.

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11. (2) 10th segment
Anal cerci are a pair of jointed, filamentous sensory structures found in both male and female cockroaches. They are located on the tenth abdominal segment and serve to detect vibrations or air movements in the environment. These structures are distinct from anal styles, which are only present in males, helping to differentiate the sexes through their external morphological features.

These sensory appendages are crucial for the survival of the cockroach, providing information about potential threats. Located at the very end of the abdomen, the tenth segment supports these cerci in both sexes. Their presence is a hallmark of the insect's anatomy, functioning as sensitive detectors that alert the animal to movement, which is vital for its nocturnal lifestyle.

12. (1) A-IV, B-II, C-III, D-I
In the cockroach, the crop acts as a sac for storing food. Gastric caeca are blind tubules that secrete digestive juices at the foregut-midgut junction. Malpighian tubules are thin filaments at the midgut-hindgut junction responsible for excretion. The gizzard, or proventriculus, contains chitinous teeth used for grinding food particles. These structures ensure efficient mechanical and chemical digestion processes.

The digestive tract is divided into specialized regions to handle food efficiently. Storage occurs in the crop before mechanical breakdown in the gizzard. Chemical digestion is assisted by secretions from the gastric caeca. Finally, the Malpighian tubules remove nitrogenous wastes from the haemolymph, integrating digestion and excretion. This complex system allows the cockroach to utilize a wide variety of food sources.

13. (4) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
Columnar epithelium lines the stomach and intestine to facilitate secretion and absorption. Ciliated epithelium moves mucus or particles along the bronchioles. Squamous epithelium forms the thin endothelium of blood vessels for efficient diffusion. Cuboidal epithelium is commonly found in the ducts of glands. These specific cell shapes and arrangements are adapted to the functional requirements of their respective bodily locations.

Epithelial tissues are classified by their cell layers and shapes, which directly correlate to their functions. Columnar cells provide surface area for nutrient uptake, while ciliated cells ensure the clearing of respiratory passages. The thinness of squamous cells is perfect for gas and nutrient exchange. Cuboidal cells are structurally sound for duct walls and active in secretion, maintaining body health.

14. (3) Both statement I and statement II are true.
Goblet cells are specialized unicellular glands found within the epithelial lining of the respiratory and intestinal tracts, where they secrete mucus. Earwax, or cerumen, is produced by ceruminous glands, which are a type of exocrine gland. Exocrine glands discharge their secretions through ducts onto epithelial surfaces. Both statements accurately describe the biological nature and classification of these secretory structures.

Understanding gland types is essential in histology. Unicellular glands like goblet cells operate individually within a tissue layer. Exocrine glands, such as those producing earwax or saliva, release their products to specific locations via ducts. This contrasts with endocrine glands, which are ductless and release hormones into the blood. Both goblet cells and ceruminous glands are vital for protection and lubrication.

15. (4) Both statement I and statement II are false.
Ligaments are classified as dense regular connective tissue because their collagen fibers are arranged in parallel bundles to provide high tensile strength. Cartilage is categorized as a specialized connective tissue characterized by a solid, pliable matrix. It is not considered a dense regular tissue. Therefore, both descriptions provided regarding the histological classification of ligaments and cartilage are scientifically inaccurate.

Connective tissues are grouped based on the density and arrangement of their fibers and the nature of their matrix. Dense regular tissues like ligaments and tendons have fibers aligned for directional strength. Cartilage, however, is a specialized support tissue with a unique chondrin-based matrix. Correctly identifying these classifications is fundamental for understanding the structural components and mechanical properties of the human body.

16. (1) A-II, B-I, C-IV, D-III
Mast cells are specialized components found within areolar connective tissue. The inner surface of bronchioles is lined with ciliated

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epithelium to move mucus. Blood is considered a specialized connective tissue because it has a fluid matrix called plasma. The tubular parts of nephrons in the kidney are composed of cuboidal epithelium, which is essential for the processes of secretion and absorption.

Tissues are organized into specific patterns to meet physiological needs. Areolar tissue provides a flexible framework where mast cells reside. Ciliated cells protect the lungs by transporting debris. The fluid nature of blood allows for the transport of nutrients and gases throughout the body. Cuboidal cells in the kidney tubules are adapted for the intense metabolic activity required for urine formation.

17. (4) Both statement I and statement II are false.
In cockroaches, the forewings, known as tegmina, are opaque, dark, and leathery; they arise from the mesothorax, not the prothorax. The hindwings are transparent and membranous, serving as the primary organs for flight, and they originate from the metathorax. Consequently, both statements incorrectly describe the origin and physical characteristics of the forewings and hindwings found in these insects.

The thoracic segments of the cockroach bear specific appendages. The prothorax has no wings, the mesothorax bears the protective tegmina, and the metathorax bears the functional flight wings. Misidentifying the origin or physical nature of these structures leads to an incorrect understanding of insect morphology. Proper knowledge of these features is essential for studying the anatomy and locomotion of arthropods.

18. (2) uricotelic only
Cockroaches are classified as uricotelic organisms because they primarily excrete nitrogenous waste in the form of uric acid. This adaptation is highly beneficial for terrestrial life as it helps conserve water, since uric acid is relatively non-toxic and can be eliminated as a semi-solid paste. The Malpighian tubules are the main organs responsible for extracting these wastes from the haemolymph.

Excretion in cockroaches is adapted for water conservation in dry environments. By producing uric acid, the insect minimizes water loss during the removal of nitrogenous metabolic byproducts. Along with Malpighian tubules, other tissues like the fat body and nephrocytes also participate in waste processing. This uricotelic strategy is a common feature among many terrestrial insects and some other animal groups.

19. (1) A-III, B-II, C-IV, D-I
Taenia uses specialized flame cells for excretion and osmoregulation. Paramecium utilizes a contractile vacuole to manage water balance within its cell. Periplaneta, the cockroach, employs the urecose gland along with other structures for nitrogenous waste removal. Pheretima, the earthworm, possesses nephridia as its primary excretory organs. These different mechanisms highlight the diversity of waste management strategies across various animal groups.

Animals have evolved specific structures to maintain internal balance and remove toxins. Whether it is the simple flame cell of a flatworm or the complex nephridia of an earthworm, these organs are vital. In insects like the cockroach, specialized glands like the urecose gland assist in the process. Such diversity in excretory organs reflects the evolutionary adaptations to different habitats.

20. (4) Presence of anal styles
Sexual dimorphism in cockroaches is clearly exhibited by the presence of anal styles in males. These are a pair of short, unjointed thread-like structures located on the ninth sternum of the male abdomen. Females lack these structures entirely. While both sexes possess jointed anal cerci on the tenth segment, the anal styles serve as a definitive external feature for sex identification.

External morphology is often used to distinguish between male and female insects. In cockroaches, the anal styles provide a clear visual indicator of the male sex. These structures are involved in sensing and potentially during mating. Understanding these anatomical differences is important for biological studies and population management. Other features like body color or anal cerci do not distinguish the sexes.

21. (1) B, C and D only
In cockroaches, excretion is a multifaceted process involving several structures. The Malpighian tubules are the primary organs, but the fat body, nephrocytes, and urecose glands also play significant roles in the elimination of nitrogenous wastes. These components collectively assist in processing and removing uric acid from the

haemolymph. Phallic and collateral glands are reproductive structures and are not involved.

The excretory system of the cockroach is designed for efficiency and water conservation. By utilizing multiple tissues like the fat body and specialized cells like nephrocytes, the insect can effectively manage its internal environment. Uricose glands in males also participate in storage excretion. This integrated approach ensures that metabolic byproducts are safely processed and eliminated as uric acid, supporting survival in terrestrial habitats.

22. (4) Neuroglia
Connective tissues like blood, adipose tissue, and cartilage are characterized by cells embedded in an extracellular matrix. Neuroglia, however, are specialized supporting cells found within the nervous system. They provide structural support, insulation, and nourishment to neurons but do not belong to the connective tissue category. Instead, they are a primary component of neural tissue, performing vital non-conductive functions.

Tissues are classified based on their embryonic origin and structural characteristics. Connective tissue serves to bind and support other tissues, often having a prominent matrix. Neural tissue is specialized for communication and support within the brain and nerves. While neuroglia are essential for nervous system health, they are fundamentally different from connective tissues like blood or cartilage in both form and function.

23. (2) Cartilage
The adjacent bones of the vertebral column are separated by intervertebral discs composed of fibrocartilage. This cartilage acts as a cushion, absorbing shocks and providing flexibility to the spine while allowing for limited movement between the vertebrae. It prevents the bones from grinding against each other during physical activity. Areolar tissue, smooth muscles, and intercalated discs do not perform this function.

Cartilage is a resilient and flexible connective tissue crucial for skeletal health. In the vertebral column, it provides the necessary cushioning between vertebrae to handle mechanical stress. This specialized arrangement allows for the flexibility of the back while protecting the spinal cord and maintaining structural integrity. Without these cartilaginous discs, the repetitive motions of the body would cause significant damage to the bones.

24. (1) (A)-(iv), (B)-(iii), (C)-(i), (D)-(ii)
Bronchioles are lined with ciliated epithelium to move particles. Goblet cells are specialized glandular tissues that secrete mucus. Tendons consist of dense regular connective tissue, providing high tensile strength for muscle-to-bone attachment. Adipose tissue is a type of loose connective tissue specialized for fat storage. Matching these tissues with their correct classifications is fundamental to understanding the structural organization of animals.

Diverse tissue types perform unique roles in maintaining body functions. Ciliated cells protect the airways, while glandular cells like goblet cells provide lubrication. The structural integrity of the body is maintained by dense tissues like tendons. Loose connective tissues like adipose serve as energy reservoirs and insulation. Recognizing these specific tissue types and their locations is essential for biological and medical studies.

25. (2) mesothorax
Tegmina are the leathery, opaque forewings of a cockroach that serve to protect the delicate hindwings. These structures arise from the mesothorax, which is the middle segment of the insect's thorax. During rest, the tegmina cover the transparent hindwings, which are attached to the metathorax and used for flight. The prothorax, while the first thoracic segment, does not bear any wings.

The thoracic appendages of insects are precisely organized. In cockroaches, the two pairs of wings are found on the second and third thoracic segments. The mesothoracic wings are modified for protection, while the metathoracic wings are functional for movement through the air. This anatomical arrangement is typical for many insects and is a key feature in identifying thoracic segments and their functions.

26. (4) Communication among the cells is performed by intercalated discs.
Smooth muscles are involuntary, non-striated, and fusiform cells found in the walls of internal organs like blood vessels. Unlike cardiac muscle, smooth muscle cells do not possess intercalated discs. Intercalated discs are specialized junctional complexes found exclusively in cardiac muscle tissue to synchronize heart contractions.

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1991

107. Earthworm possesses hearts
(1) 6 pairs
(2) 4 pairs
(3) 2 pairs
(4) 1.

1991

108. Male and female cockroaches can be distinguished externally through
(1) anal styles in male
(2) anal cerci in female
(3) anal style and antennae in females
(4) both (b) and (c).

1990

109. Blood of Pheretima is
(1) blue with haemocyanin in corpuscles
(2) blue with haemocyanin in plasma
(3) red with haemoglobin in corpuscles
(4) red with haemoglobin in plasma.

1990

110. Pheretima posthuma is highly useful as
(1) their burrows make the soil loose
(2) they make the soil porous, leave their castings and take organic debris in the soil
(3) they are used as fish meal
(4) they kill the birds due to biomagnification of chlorinated hydrocarbons.

1990

111. Addition of a trace of thyroxine or iodine in water containing tadpoles will
(1) keep them in larval stage
(2) hasten their metamorphosis
(3) slow down their metamorphosis
(4) kill the tadpoles.

1989

112. Haversian canals occur in
(1) humerus
(2) pubis
(3) scapula
(4) clavicle.

1989

113. Histamine secreting cells are found in
(1) connective tissues
(2) lungs
(3) muscular tissue
(4) nervous tissue.

1989

114. Mineral found in red pigment of vertebrate blood is
(1) magnesium
(2) iron
(3) calcium
(4) copper.

1989

115. Earthworms are
(1) useful
(2) harmful
(3) more useful than harmful
(4) more harmful.

1989

116. Photoreceptors of earthworm occur on
(1) clitellum
(2) many eyes
(3) dorsal surface
(4) lateral sides.

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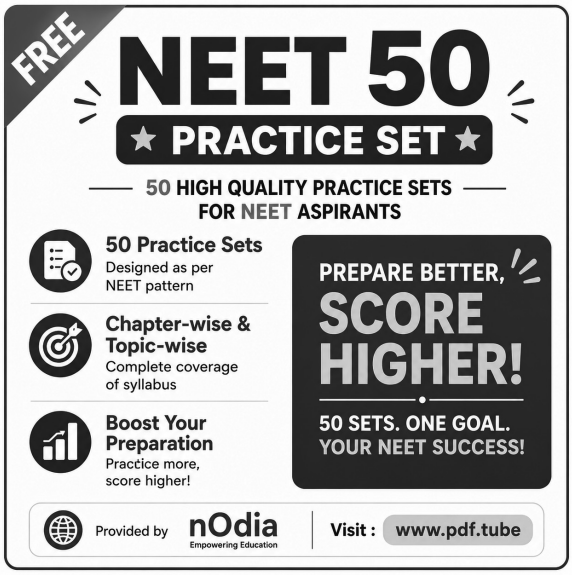

These cells maintain their columnar shape while housing the large mucus-filled vesicles for secretion.

The transformation of epithelial cells into specialized secretory units is a vital biological process. Columnar cells, being tall and robust, provide an ideal structure for becoming goblet cells. These cells ensure that sensitive linings, such as those in the alimentary canal, are shielded from chemical and mechanical damage. Understanding this relationship is fundamental to histology and the study of organ systems.

32. (3) the head holds a small proportion of a nervous system while the rest is situated along the ventral part of its body

A cockroach can survive for several days after its head is removed because its nervous system is decentralized. Only a small portion of the nervous tissue is located in the head, while the majority consists of segmentally arranged ganglia found along the ventral side of the thorax and abdomen. These ganglia can independently control many vital functions, allowing the body to persist.

The survival of a headless cockroach highlights the efficiency of its nervous system. With the supra-oesophageal and sub-oesophageal ganglia in the head and segmentally arranged ganglia elsewhere, the insect is not reliant on a single control center for basic survival. This decentralized arrangement is a significant adaptation in arthropods, enabling them to maintain movement and basic physiological processes without a head.

33. (1) bronchioles and fallopian tubes

Ciliated epithelium consists of cells with hair-like projections called cilia that move in a coordinated fashion. In humans, these cells are found in the bronchioles of the lungs to move mucus and trapped particles toward the throat. They are also located in the fallopian tubes, where they help transport the egg or zygote toward the uterus through rhythmic wave-like motions.

These specialized cells play a crucial role in maintaining health and facilitating reproduction. By generating current or moving substances across their surface, cilia ensure that airways stay clear and that gametes reach their destination. This type of epithelial tissue is found in areas where directional movement of particles or fluids is required, showcasing the functional specialization of cells within different organ systems.

34. (3) (A)-(iii), (B)-(i), (C)-(iv), (D)-(ii)

Tight junctions prevent fluid leakage across cell layers. Adhering junctions perform a cementing function to hold neighboring cells together. Gap junctions facilitate communication between cells by allowing the transfer of ions and molecules through cytoplasmic channels. Synaptic junctions are specialized sites where neurons transmit chemical signals to other cells. These different junctions are vital for the structural integrity and functional coordination of tissues.

Each cell junction has a specific role in maintaining tissue organization and function. From providing mechanical strength to ensuring chemical and electrical communication, these structures are essential. Understanding how tight, adhering, gap, and synaptic junctions operate allows for a better grasp of histology and physiology. They are fundamental components that allow individual cells to work together as a cohesive and functional tissue.

35. (2) Pharynx → Oesophagus → Crop → Gizzard → Ileum → Colon → Rectum

The alimentary canal of a cockroach follows a specific anatomical sequence starting from the mouth. Food passes through the pharynx and oesophagus into the crop, where it is stored. It then enters the gizzard for mechanical grinding. Afterward, the food moves into the midgut and then into the hindgut, which is composed of the ileum, colon, and finally the rectum for waste.

This organized structure allows the cockroach to process food efficiently through storage, grinding, digestion, and waste removal. Each section of the gut is specialized for a different stage of the digestive process. For example, the gizzard's chitinous teeth are essential for physical breakdown. Knowing this sequence is fundamental for understanding insect anatomy and the physiology of digestion in common household pests.

36. (2) Presence of caudal styles

Male cockroaches can be distinguished from females by the presence of caudal styles, also known as anal styles. These are a pair of short, unjointed, thread-like structures found on the ninth abdominal sternum in males. Females do not possess these structures. Both sexes have jointed anal cerci on the tenth segment, making

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the pupil in response to light. Biceps of the upper arm and muscles of the abdominal wall are skeletal muscles, which are voluntary and striated. The heart wall is composed of cardiac muscle, which is involuntary and striated. Therefore, only the pairing of the iris is biologically accurate.

Muscles are classified based on their structure and whether we can control them. Skeletal muscles for movement are voluntary. Smooth muscles in internal organs like the iris or digestive tract are involuntary. Cardiac muscle is unique to the heart. Correctly matching these muscle types with their body parts is essential for understanding how different systems are controlled by the nervous system.

67. (2) ciliated

The inner surfaces of the bronchioles in the respiratory tract and the fallopian tubes in the female reproductive system are lined with ciliated epithelium. These cells possess fine, hair-like projections called cilia that beat rhythmically. This movement serves to transport mucus and trapped particles in the airways or to move the egg cell through the fallopian tube toward the uterus for potential development.

This specialized tissue is essential for directing the flow of materials through narrow passages. In the respiratory system, it acts as a defense mechanism to keep the lungs clean. In the reproductive system, it ensures that the egg reaches its destination. Understanding where ciliated epithelium is located helps in grasping how different organs manage the movement of small particles or cells.

68. (2) epithelial tissue

Tight, adhering, and gap junctions are specialized structures primarily found in epithelial tissues. They serve various functions: tight junctions prevent fluid leakage, adhering junctions provide mechanical stability by cementing cells together, and gap junctions facilitate direct communication by allowing the passage of ions. While some junctions exist in other tissues, they are a hallmark feature of the organized cell layers in epithelia.

These junctions are critical for the formation and function of epithelial sheets that line our bodies and organs. They ensure that cells stay together under stress and can share signals and materials as needed. This structural organization is a defining characteristic of epithelial tissue, making it distinct from other tissue types like neural or muscular tissue, where different connection types may dominate.

69. (3) tip of the nose

The pinna, or external ear, is supported by elastic cartilage, which provides both flexibility and structural integrity. This type of supportive tissue is also found at the tip of the nose, allowing it to maintain its shape while remaining pliable. Nails are composed of keratin, ear ossicles are small bones, and vertebrae are larger bones. Thus, the nose tip is the matching location.

Cartilage provides a firm yet flexible framework for certain parts of the body. By comparing the supportive structures in the ear and the nose, we can see how this tissue type is utilized where rigidity is not desired. Understanding these similarities is important for identifying tissue types across different organs. Other structures like nails or bones have fundamentally different compositions despite their supportive roles.

70. (3) Two pairs of testes in 10th and 11th segments

In the earthworm Pheretima, the reproductive organs are located in specific segments. There are two pairs of testes situated in the 10th and 11th segments. Four pairs of spermathecae are actually found in segments 6 to 9. One pair of ovaries is attached at the intersegmental septum of the 12th and 13th segments. Two pairs of accessory glands are present in the 17th and 19th segments.

Precise segmental location of organs is a key aspect of earthworm anatomy. Knowing that the testes are in segments 10 and 11 is essential for understanding their reproductive system. Misplacing other organs like ovaries or spermathecae highlights the importance of detailed anatomical knowledge. Each segment in an annelid's body is carefully organized to house specific vital organs for survival and reproduction.

71. (1) coelomic fluid

When a live earthworm is pricked superficially without damaging the internal gut, the liquid that emerges is the coelomic fluid. This fluid fills the coelom, which is the body cavity located between the body wall and the digestive tract. Coelomic fluid acts as a hydrostatic skeleton and contains various cells. It is distinct from haemolymph, which is confined within a closed circulatory system.

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Sperm storage and maturation are critical steps in the reproductive cycle of the cockroach. The seminal vesicles provide a specialized environment for maintaining sperm until they are needed for mating. This storage mechanism, combined with the formation of spermatophores, is an essential adaptation for successful fertilization. Understanding these reproductive structures is key to studying the life cycle and biology of these insects.

42. (4) Indeterminate and radial cleavage during embryonic development

Periplaneta americana, the common cockroach, belongs to the group of protostomes. Therefore, it exhibits determinate and spiral cleavage during its embryonic development, rather than indeterminate and radial cleavage, which is characteristic of deuterostomes like chordates. It does possess a chitinous exoskeleton, a metamerically segmented body, and a schizocoelom, which are typical features of arthropods and specifically the class Insecta.

Developmental patterns are fundamental for classifying animals into major groups. Cockroaches follow the protostome pathway, where the fate of embryonic cells is determined early. This contrast with deuterostomes is a key evolutionary distinction. While cockroaches share many general arthropod traits like segmented bodies and chitinous exoskeletons, their specific embryonic cleavage pattern is a defining biological characteristic that separates them from other animal phyla.

43. (4) facilitate communication between adjoining cells by connecting the cytoplasm for rapid transfer of ions, small molecules and some large molecules.

Gap junctions are specialized intercellular connections that allow for direct communication between neighboring cells. They form protein channels that bridge the gap between the cytoplasms of adjacent cells. This allows for the rapid exchange of ions, nutrients, and chemical signals, which is vital for coordinating activities in tissues like cardiac muscle. They are distinct from tight junctions, which prevent leakage between cells.

The ability of cells to communicate rapidly is essential for the function of many tissues. Gap junctions provide a low-resistance pathway for signals to travel, ensuring that groups of cells can act as a single unit. This is particularly important in systems where synchronized activity is required. Understanding these junctions is fundamental to histology and cell biology, highlighting how cellular coordination is achieved.

44. (4) potassium urate

In cockroaches, the Malpighian tubules absorb nitrogenous wastes from the surrounding haemolymph primarily in the form of potassium urate. Inside the tubules, this potassium urate is converted into uric acid through a series of chemical reactions. The uric acid is then excreted along with the feces. This uricotelic nature is an essential adaptation for the insect to conserve water in terrestrial environments.

Water conservation is a critical challenge for terrestrial insects like the cockroach. By excreting uric acid, which requires very little water for removal, the insect can survive in relatively dry habitats. The process starts with potassium urate being removed from the haemolymph by the Malpighian tubules. This efficient excretory strategy is a key biological feature that supports the overall survival and success of cockroaches.

45. (1) arthrodial membrane

The body of a cockroach is covered by a hard chitinous exoskeleton composed of hardened plates called sclerites. These sclerites include the dorsal terga, ventral sterna, and lateral pleura. To allow for movement and flexibility, these rigid plates are joined together by a thin, flexible, and tough articular membrane known as the arthrodial membrane. This structure facilitates the insect's locomotion and bodily expansion.

The exoskeleton provides protection while the arthrodial membrane ensures flexibility. This combination is vital for the cockroach's ability to move quickly and navigate tight spaces. The segmented nature of the body requires these flexible joints between the hardened sclerites. Understanding these anatomical features is essential for studying insect movement and the structural biology of arthropods, showing how they balance protection with agility.

46. (3) Areolar tissue - Loose connective tissue

Areolar tissue is a classic example of loose connective tissue, characterized by a semi-fluid matrix containing various cells and fibers. Tendons are actually dense regular connective tissue, not specialized. Adipose tissue is classified as loose connective tissue, not dense. Cartilage

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the anal styles the key diagnostic feature for male identification.

Identifying the sex of a cockroach involves looking at specific external appendages. While anal cerci are common to both males and females, the anal styles are exclusive to males. This difference is an example of sexual dimorphism and is used by biologists to sort and study these insects. Understanding these morphological details is essential for accurate anatomical descriptions and biological research.

37. (3) Testes → Vasa efferentia → Kidney → Bidder's canal → Urinogenital duct → Cloaca
In male frogs, sperms are produced in the testes and transported via the vasa efferentia into the kidneys. From the kidneys, they enter Bidder's canal and then travel through the urinogenital duct. This duct carries both urine and sperm to the cloaca, from which they are expelled. This pathway is unique to amphibians, where the urinary and reproductive systems are closely linked.

The reproductive anatomy of male frogs shows a close integration with the urinary system. The sperm route through the kidney and Bidder's canal highlights this anatomical relationship. Finally, the cloaca acts as a common chamber for waste and gamete release. Understanding this sequence is fundamental for studying amphibian biology and reproductive physiology, illustrating how these animals have adapted their organ systems for breeding.

38. (3) (3) and (4)
A frog's heart continues to beat after removal because it is myogenic, meaning the rhythmic contractions originate within the muscle tissue itself rather than from external nervous stimulation. Additionally, the heart is autoexcitable, possessing specialized cells that spontaneously generate electrical impulses to trigger contractions. These intrinsic properties allow the heart to maintain its rhythm temporarily even when disconnected from the central nervous system.

Myogenic hearts are characterized by their ability to generate contractions independently of external signals. This autoexcitability is a key feature that ensures continuous blood flow. In frogs, these internal mechanisms are robust enough to keep the heart functioning outside the body for a period. This is an important physiological trait in many vertebrates, allowing for sustained cardiac activity regardless of nervous input.

39. (1) involuntary, fusiform, non-striated
Smooth muscles are characterized by spindle-shaped, or fusiform, cells that lack the striations found in skeletal or cardiac muscle. They are involuntary, meaning their movements are not under conscious control. These muscles are typically found in the walls of hollow internal organs such as the stomach, intestines, and blood vessels, where they regulate functions like peristalsis and blood flow.

Muscle tissue types are classified by their physical appearance and how they are controlled. Smooth muscle is unique in its lack of visible bands and its involuntary nature. These cells are specialized for slow and sustained contractions, which are essential for managing internal organ functions. Understanding these properties is vital for studying human physiology and the various mechanisms that control bodily processes.

40. (3) Smooth muscle Wall of intestine
Smooth muscle is correctly matched with its location in the wall of the intestine, where it facilitates involuntary movements like peristalsis. Transitional epithelium is found in the urinary bladder, not the nose tip. Cuboidal epithelium lines kidney tubules, whereas the stomach is lined with columnar epithelium. Areolar tissue is a loose connective tissue found beneath the skin, while tendons are dense regular tissue.

Correctly identifying the location of various tissue types is a fundamental skill in biology. Different tissues are specialized for the specific functional requirements of their respective organs. Smooth muscle in the intestinal wall ensures that food moves through the digestive tract. Misidentifying tissue locations, such as putting areolar tissue in tendons, overlooks the specialized adaptations of dense and loose connective tissues.

41. (1) Seminal vesicles
In male cockroaches, sperms are produced in the testes and then travel through the vasa deferentia. They are eventually stored in the seminal vesicles, which are part of the mushroom-shaped gland complex. In these vesicles, the sperms are glued together into bundles called spermatophores, which are later discharged during copulation. This ensures the organized transfer of sperm to the female reproductive system.

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51. (1) Spiracle in metathorax, trachea, tracheoles, oxygen diffuses into cells

Air enters the cockroach respiratory system through small external openings called spiracles, located on the lateral sides of the body, including the metathorax. From the spiracles, air travels through a network of tubes called tracheae, which branch into smaller tracheoles. The tracheoles carry oxygen directly to the tissues and cells. This tracheal system allows for efficient gas exchange without the need for blood pigments.

The respiratory pathway in cockroaches is direct and efficient. By using a system of tubes that reach every part of the body, oxygen can reach cells through simple diffusion. This bypasses the need for a complex circulatory transport of gases. Understanding the order of these structures—from spiracles to tracheoles—is key to grasping how insects manage respiration in a terrestrial environment.

52. (1) Macrophage Fibroblast Collagen fibres Mast cell

In a diagram of areolar connective tissue, the different components can be identified by their structure. Macrophages are large phagocytic cells. Fibroblasts are the most abundant cells, responsible for secreting fibers like collagen. Collagen fibers appear as thick, unbranched bundles that provide tensile strength. Mast cells are involved in inflammatory responses. These components are embedded in a semi-fluid ground substance to form the loose tissue.

Each cell and fiber type within areolar tissue has a specific role. Fibroblasts create the structural framework, while macrophages and mast cells are key for defense and inflammation. Collagen provides the strength needed to hold tissues together. Recognizing these parts in a diagram is fundamental for histology, as areolar tissue is widely distributed and serves as a model for loose connective tissues.

53. (4) cartilage.

Cartilage is a resilient and flexible type of specialized connective tissue. In the human body, elastic cartilage provides the structural support for the external ear, or pinna, while hyaline cartilage forms the supportive framework at the tip of the nose. These structures require a balance of firmness and flexibility that cartilage provides, unlike bones which are rigid or ligaments which connect bones.

The flexibility of our ears and nose is due to the unique properties of cartilage. This tissue can maintain its shape while allowing for significant bending and movement. Different types of cartilage are specialized for various parts of the body, such as the nose tip and the external ear. Knowing these examples helps in understanding the diverse functions and locations of specialized connective tissues.

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54. (1) (B) Glandular epithelium, Intestine, Secretion

Glandular epithelium is specialized for secretion and is found in the lining of the stomach and intestine, often forming glands. Columnar epithelium, which can be secretory and absorptive, also lines these organs. Tissues like collagen fibers are found in tendons and ligaments, while smooth muscles are found in the walls of visceral organs, but not the heart. Cardiac muscle is unique to the heart wall.

Matching tissues with their correct location and function is vital for understanding biology. Glandular cells in the intestine produce the necessary enzymes and mucus for digestion. Other tissues, like cardiac muscle, have very specific roles that cannot be performed by types like smooth muscle. Recognizing these correct combinations is key to accurately describing the physiological processes that sustain life in different organ systems.

55. (2) decaying fallen leaves and soil organic matter

Pheretima, the earthworm, is a detritivore that feeds on organic matter found in the soil. Its diet primarily consists of decaying fallen leaves and other decomposing plant and animal materials mixed with earth. As it burrows, it ingests large quantities of soil, from which it extracts nutrients through its digestive system. This feeding behavior plays a vital role in nutrient cycling and soil improvement.

By consuming organic debris, earthworms act as important decomposers in their ecosystems. They break down complex materials into simpler forms, which enriches the soil and makes nutrients more available for plants. This process of soil processing and nutrient extraction is a fundamental part of the earthworm's life cycle. Understanding their diet helps explain why they are so beneficial for soil fertility and garden health.

56. (2) Males bear a pair of short thread like anal styles.
In Periplaneta americana, male cockroaches are distinguished by the presence of a pair of short, unjointed anal styles on the ninth abdominal sternum. The nervous system is located ventrally, not dorsally. There are approximately 100 to 150 Malpighian tubules, rather than just 16. While mouthparts like mandibles assist in grinding food, the gizzard in the alimentary canal is also significantly involved in mechanical digestion.

Correct anatomical descriptions are essential for studying insect biology. The presence of anal styles is a reliable external marker for sexing cockroaches. Furthermore, understanding the true location of the nervous system and the correct number of excretory tubules is necessary for a precise understanding of their physiology. These details help distinguish the common cockroach from other insects and animal groups.

57. (2) nucleated and with haemoglobin
Frog erythrocytes, or red blood cells, differ from mature human erythrocytes in that they contain a nucleus. Despite being nucleated, they still possess the iron-containing pigment haemoglobin, which is responsible for transporting oxygen throughout the frog's circulatory system. In contrast, mature human red blood cells lose their nuclei to maximize space for haemoglobin. This difference in cell structure is a characteristic distinction.

The presence of a nucleus in frog red blood cells is a notable feature in comparative physiology. While humans have evolved enucleated erythrocytes to increase oxygen-carrying efficiency, frogs maintain a more ancestral cell structure. Both types of cells, however, rely on haemoglobin for the vital function of gas transport. Recognizing these differences is fundamental for understanding the diversity of circulatory systems across different vertebrate groups.

58. (2) bronchioles and Fallopian tube
Ciliated columnar epithelium consists of tall cells with hair-like cilia on their free surfaces. These cells are specialized for moving particles or fluids in a specific direction. In the human respiratory tract, they line the bronchioles to move mucus. In the female reproductive system, they line the fallopian tubes to assist in the movement of the ovum or zygote toward the uterus through ciliary beats.

These cells are found in areas where transport of small materials across a surface is required. In the lungs, they help keep the airways clear by moving mucus and trapped particles upward. In the reproductive system, they ensure that the egg reaches the uterus for potential implantation. Understanding the location and function of ciliated columnar epithelium is essential for studying these two vital organ systems.

59. (2) squamous epithelium
The cells lining the blood vessels form a thin, single layer known as the endothelium. This layer is composed of simple squamous epithelium, which consists of flat, tile-like cells. This structural arrangement is ideal for facilitating the efficient diffusion of gases, nutrients, and waste products between the blood and the surrounding tissues. It provides a smooth surface that reduces friction for blood flow throughout the system.

Simple squamous epithelium is adapted for filtration and diffusion due to its extreme thinness. Its presence in blood vessels is a key anatomical feature that supports the circulatory system's function. By allowing substances to pass through easily, these cells enable rapid exchange at the capillary level. Recognizing this tissue type in the context of vascular anatomy is fundamental to understanding human physiology and histology.

60. (2) the typhlosole greatly increases the effective absorption area of the digested food in the intestine
The typhlosole is a prominent internal median fold of the dorsal wall of the intestine in earthworms, specifically from the 26th segment onwards. Its primary function is to significantly increase the surface area available for the absorption of nutrients from digested food. This enhancement of digestive efficiency is a key adaptation for their lifestyle. Other features mentioned are either incorrect or not unique.

This anatomical adaptation allows the earthworm to maximize the nutrients it extracts from its soil-heavy diet. By increasing the internal surface area, the typhlosole ensures that the animal remains healthy while processing large volumes of earth. Understanding the role of this structure is fundamental for studying the digestive physiology of annelids and how they have evolved to thrive as soil-dwelling organisms.

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61. (1) Clitellum - Secretes cocoon
In Pheretima, the clitellum is a prominent glandular tissue band found in segments 14 to 16. Its primary function is to secrete a cocoon into which eggs and sperms are deposited for external fertilization and development. The gizzard is responsible for grinding food, not absorption. Setae are used for locomotion, not defense. The typhlosole increases the intestinal surface area for nutrient absorption, rather than storage.

The clitellum is a key reproductive structure in earthworms, appearing as a distinctive thickened band on the body. Its role in cocoon formation is vital for the protection of developing embryos. Misidentifying the functions of other structures like the gizzard or setae highlights the importance of accurate anatomical knowledge. Each part of the earthworm's body is specialized for a particular survival or reproductive task.

62. (4) The food is ground by mandibles and gizzard.
Digestion in the common cockroach involves mechanical breakdown of food at two main sites. The mandibles are part of the mouthparts used for biting and initial grinding. Later, the gizzard, or proventriculus, uses its internal chitinous teeth to further pulverize food particles before they enter the midgut. Malpighian tubules are excretory organs at the midgut-hindgut junction, and oxygen is transported through a tracheal system.

The process of grinding food is essential for efficient digestion in cockroaches. By using both the external mandibles and the internal gizzard, the insect can break down a wide variety of materials. Other statements about excretion and gas transport are incorrect because they misidentify the organs and transport mechanisms. Knowing the correct functions of these structures is key to understanding the cockroach's physiology.

63. (3) nucleated red blood cells
A significant physiological difference between frogs and humans is the structure of their red blood cells. Frogs possess nucleated erythrocytes, meaning their red blood cells contain a nucleus even when mature. In contrast, mature human red blood cells are enucleated, lacking a nucleus to provide more space for oxygen-carrying haemoglobin. Both organisms possess paired cerebral hemispheres, hepatic portal systems, and thyroid glands.

The nucleus in frog red blood cells is a classic distinction in vertebrate hematology. While humans have adapted by removing the nucleus to optimize oxygen transport, frogs maintain this cell component. This difference is often used as a comparative point in biology. Other anatomical features like the hepatic portal system are shared between the two groups, making the nucleated state of the blood cells unique.

64. (4) male frogs.
In male frogs, the ureters serve a dual purpose by transporting both urine from the kidneys and sperms from the testes. Consequently, they are referred to as urinogenital ducts. They open into the cloaca for the elimination of both waste and reproductive cells. In female frogs, however, the ureters and oviducts remain separate, and in humans, these systems are anatomically distinct in both sexes.

The integration of the urinary and reproductive systems in male frogs is a key anatomical characteristic. By using the same duct for both products, the system is streamlined. This contrasts with female frogs and humans, where separate pathways exist for eggs and urine. Understanding this unique urinogenital duct is essential for studying amphibian anatomy and the different ways animals manage waste and reproduction.

65. (1) T F F T
Rana tigrina, the common frog, exhibits various biological traits. It utilizes its skin, lungs, and buccal cavity for respiration on land; however, if the mouth is kept open, buccal respiration is hindered, potentially leading to death. The frog heart has three chambers, not four. Frogs are typically ureotelic and do not switch to being uricotelic. Their life history includes an aquatic tadpole stage carried out in pond water.

Understanding the true and false aspects of frog biology is fundamental. While cutaneous respiration is vital, the buccal cavity also plays a role on land. The three-chambered heart and ureotelic nature are key physiological features. Finally, the aquatic environment is necessary for their early development. Knowing these facts allows for a correct assessment of the animal's life cycle and metabolic processes.

66. (3) Iris - Involuntary smooth muscle
The iris of the eye contains smooth muscle fibers that are involuntary, controlling the diameter of

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is a specialized connective tissue with a solid matrix, rather than loose. Thus, only the pairing of areolar tissue with loose connective tissue is correct.

Classifying connective tissues correctly is fundamental in anatomy and histology. Areolar tissue's loose arrangement of fibers makes it flexible and widely distributed throughout the body as a support framework. Misidentifying dense tissues like tendons or specialized tissues like cartilage highlights common errors in tissue classification. Recognizing the specific properties and categories of each tissue type is essential for understanding how the body is built.

47. (3) Tubular parts of nephrons - Cuboidal epithelium

The tubular parts of nephrons, such as the proximal convoluted tubule, are lined with simple cuboidal epithelium to facilitate secretion and reabsorption. Salivary ducts are typically lined by compound or cuboidal epithelium, while the moist buccal cavity features non-keratinized stratified squamous epithelium. Bronchioles are lined with ciliated columnar or cuboidal epithelium to move mucus. Therefore, the nephron-cuboidal epithelium pairing is the correct one.

Epithelial tissues are highly specialized for the functions of the organs they line. In the kidney nephrons, cuboidal cells provide the necessary surface area and metabolic machinery for active transport. Other types of epithelia, like squamous or ciliated, are found in locations where diffusion or movement of materials is the primary requirement. Correct matching is key to understanding how these tissues support organ function.

48. (4) Skeletal muscles show striations and are closely attached with the bones of the limbs

Skeletal muscle tissue is characterized by long, cylindrical, unbranched fibers that exhibit distinct light and dark bands called striations. These muscles are voluntary and are typically attached to the skeleton, such as the bones of the limbs, via tendons. They facilitate body movement through conscious control. Cardiac muscles are also striated but are branched and involuntary, while smooth muscles are non-striated and fusiform.

The structural features of muscle types define their physiological roles. Skeletal muscle's unbranched, striated fibers are built for powerful and controlled movements. This contrasts with the branched structure of cardiac muscle and the smooth, spindle shape of visceral muscles. Understanding these differences, along with their typical locations in the body, is fundamental for studying human anatomy and the mechanics of movement.

49. (1) Both forewings and hindwings develop

Cockroaches undergo paurometabolous development, which includes a series of nymphal stages. The nymphs resemble adults but lack wings and mature reproductive organs. In the penultimate nymphal stage, wing pads are present, but it is only after the final moult into the adult stage that both the forewings and hindwings fully develop. This transition marks the insect attainment of sexual maturity and its flight capability.

The development from nymph to adult involves significant external changes. The appearance of functional wings is a definitive marker of the final moult. This developmental process allows the insect to grow and eventually gain the ability to fly and reproduce. Knowing these stages is important for understanding the life cycle and biology of cockroaches, which differ from insects with complete metamorphosis.

50. (2) Males bear short anal styles not present in females.

Male cockroaches possess a pair of short, unjointed anal styles on the ninth abdominal sternum, which are absent in females. This is a primary external characteristic for sex determination. Malpighian tubules excrete uric acid, not urea. The nervous system consists of segmentally arranged ganglia on a ventral, not dorsal, nerve cord. The forewings, or tegmina, are leathery and protect the hindwings used for flight.

Distinguishing features between cockroach sexes and their general anatomy are essential biological facts. The presence of anal styles is a reliable way to identify males. Furthermore, understanding the correct location of the nerve cord and the function of various wing pairs provides a complete picture of the insect's structure. These anatomical details are fundamental to the study of entomology and common insect biology.

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The coelomic fluid is a vital part of the earthworm's physiology, providing support and allowing for movement. It also plays a role in internal transport and defense. When the outer surface is breached, this pressurized fluid leaks out. Understanding the nature of this fluid helps in grasping the concept of a coelom and how simple invertebrates maintain their body shape and function.

72. (3) coelomic fluid
Earthworms lack a hard bony skeleton and instead rely on a hydrostatic skeleton for movement. This is created by the pressurized coelomic fluid within their segmented body cavity. During burrowing, the contraction of muscles against this fluid makes the anterior end turgid, providing the necessary rigidity to push through the soil. Setae provide anchorage, but the hydraulic force is generated by the fluid.

The use of fluid pressure for locomotion is a fascinating biological adaptation. By manipulating the volume and pressure of coelomic fluid in different segments, the earthworm can effectively move through dense soil. This hydraulic mechanism is essential for their burrowing lifestyle. Understanding how coelomic fluid acts as a skeleton is fundamental to the study of invertebrate anatomy and the mechanics of their movement.

73. (2) Cockroach - 10 pairs of spiracles (2 pairs on thorax and 8 pairs on abdomen)
The respiratory system of a cockroach features ten pairs of spiracles, with two pairs located on the thorax and eight pairs on the abdomen. In rats, the right kidney is typically slightly higher. The earthworm alimentary canal sequence is pharynx, oesophagus, gizzard, stomach, and intestine. Frogs have bodies divisible into head and trunk but lack a neck. Thus, the cockroach description is accurate.

Detailed anatomical facts are necessary for correctly identifying and describing different animals. The number and location of spiracles in a cockroach are definitive characteristics. Similarly, knowing the correct organ positions in rats, earthworms, and frogs prevents common errors in biological descriptions. These specific details are essential for any thorough study of animal morphology and the diverse ways different species are structured.

74. (4) Perikaryon and dndrites
A nerve cell, or neuron, is uniquely characterized by its specialized structure, which includes the perikaryon and dendrites. The perikaryon is the cell body containing the nucleus, while dndrites are branched projections that receive signals. While other cells have nuclei and mitochondria, the presence of dendrites and a long axon for conducting electrical impulses distinguishes neurons from all other cell types in the body.

The distinctive shape of a neuron is essential for its function in communication. By having specialized regions to receive and send signals, nerve cells can form complex networks that process information. Other cellular components like vacuoles or flagella do not define a nerve cell. Recognizing the perikaryon and dendrites is fundamental for identifying neural tissue and understanding how the nervous system operates.

75. (4) Ciliated epithelium
Cell junctions are most frequently encountered in epithelial tissues because these cells are tightly packed to form continuous sheets that line body surfaces and cavities. Ciliated epithelium requires robust connections like tight and adhering junctions to maintain structural integrity and gap junctions for coordinating ciliary movement. Connective tissues like tendons and cartilage have widely spaced cells in an abundant matrix, making junctions less prevalent.

The organization of epithelial cells into cohesive layers is made possible by various types of cell junctions. These structures ensure that the tissue can act as a single unit while maintaining a protective or secretory barrier. In ciliated types, these junctions also help in synchronizing the beating of cilia. Understanding the prevalence of junctions in epithelia is a key concept in histology and tissue biology.

76. (3) integument with muscles
Areolar tissue is the most widely distributed connective tissue in the animal body. It acts as a supporting framework and often joins the integument, or skin, to the underlying muscles. This loose connective tissue provides flexibility while holding organs and tissues in place. It contains various cells and fibers embedded in a semi-fluid matrix. Other types of connective tissue serve to connect bones.

The connection between the skin and the rest of the body is provided by this versatile tissue. Areolar tissue allows for movement and

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provides a space for blood vessels and nerves to reach the skin. This flexible attachment is vital for maintaining the integrity of the body surface. Knowing that areolar tissue links the integument to muscles is fundamental for understanding skin anatomy.

77. (4) histamine.
Mast cells are specialized cells found in connective tissues that play a significant role in inflammatory and allergic reactions. When activated, they release several potent chemicals, including histamine, which increases the permeability of blood vessels. They also secrete heparin and serotonin. Haemoglobin is found in red blood cells, myoglobin in muscle cells, and hippurin is a metabolic byproduct, none of which come from mast cells.

Histamine is a vital chemical signal for the immune system. By releasing this substance, mast cells can trigger an immediate response to injury or irritation. This is a key part of how the body defends itself and manages inflammation. Understanding the specific secretions of mast cells is essential for grasping how the immune and circulatory systems interact within the connective tissues.

78. (1) ammonotelic when plenty of water is available
Earthworms exhibit a flexible excretory strategy known as poikilosmotic behavior. When water is abundant in their environment, they primarily excrete nitrogenous waste in the form of ammonia, making them ammonotelic. However, under drier conditions, they switch to excreting urea and become ureotelic. This adaptability helps the earthworm survive in varying soil moisture levels. They are not typically uricotelic under normal conditions.

Excretory flexibility is a major survival tactic for soil-dwelling animals. By changing their waste product based on water availability, earthworms can maintain their internal balance in changing environments. When water is plentiful, ammonia is a cost-effective waste to produce. In drier times, urea is safer and saves water. This biological trait highlights the sophisticated ways simple organisms have evolved to thrive in their habitats.

79. (2) Neurons
Neurons are the primary functional units of the nervous system and are generally characterized by a lack of regenerative capacity in adults. Once damaged or dead, they are least likely to be replaced by new cells because they remain in the G_0 phase and do not undergo division. In contrast, liver cells, osteocytes, and skin layers possess varying degrees of regenerative ability to replace damage.

The permanent nature of most neurons is a critical factor in nervous system health and recovery from injury. Unlike other tissues that can heal through cell division, the brain and spinal cord have very limited repair mechanisms. This makes the protection of existing neurons vital. Understanding which cells can and cannot be replaced is fundamental to understanding human pathology and the limits of bodily repair.

80. (2) heparin and histamine
Mast cells, which are key components of loose connective tissue, contain granules filled with various bioactive substances. These primarily include heparin, which acts as an anticoagulant to prevent blood clotting, and histamine, which mediates inflammatory responses by dilating blood vessels. Serotonin is also often present. Hormones like vasopressin or pigments like melanin are produced by other specialized cells or glands in the body.

The contents of mast cell granules are essential for managing the local environment within connective tissues. Heparin and histamine work together to control blood flow and response to injury. This immediate release of chemicals is a cornerstone of the inflammatory process. Knowing these specific substances is fundamental for studying histology and the immune system, explaining how the body reacts at a cellular level.

81. (2) Areolar tissue
Areolar tissue is a type of loose connective tissue characterized by having a large amount of extracellular matrix relative to its cellular components. This matrix consists of a semi-fluid ground substance containing loosely arranged fibers like collagen and elastin. Epithelial, muscle, or nerve tissues are much more cellular with very little extracellular material between the closely packed cells or fibers. Thus, it contains the largest quantity.

The abundance of matrix in connective tissues like areolar tissue is a defining feature. This material provides the necessary space for vessels and nerves while offering flexible support to surrounding tissues. In contrast, other tissue types are built for communication or contraction,

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requiring a high density of cells. Recognizing which tissues have the most extracellular material is key to understanding their different structural roles.

82. (1) fibrous protein
Collagen is the most abundant protein in the animal kingdom and is classified as a fibrous protein. It consists of long, ribbon-like molecules that aggregate to form strong, inelastic fibers. These fibers provide structural support and tensile strength to various connective tissues, including tendons, ligaments, skin, and bone. Its fibrous nature is essential for maintaining the integrity and mechanical properties of the skeletal framework.

Fibrous proteins like collagen are built for strength and durability. Unlike globular proteins that may be enzymes or transporters, fibrous proteins provide the "glue" that holds the body together. The triple-helix structure of collagen makes it incredibly tough. Understanding its classification is fundamental for studying biochemistry and the structural components of the body, as it forms the basis of most connective tissues.

83. (2) Hyaline cartilage
The nasal septum is primarily composed of hyaline cartilage, which provides a balance of support and flexibility. It is the most common type of cartilage in the body, characterized by a translucent matrix with fine collagen fibers. During recovery from an injury to the nasal septum, the body naturally works to repair or replace this hyaline cartilage. Elastic and fibrous cartilages are found elsewhere.

Hyaline cartilage is the standard supportive cartilage found in many parts of the skeleton, including the nose. Its smooth and firm nature makes it ideal for maintaining the shape of the nasal passage while allowing it to be slightly flexible. Knowing which type of cartilage is found in the nose is important for medical and anatomical studies, as each type has different properties.

84. (3) Nerve cells
Nerve cells, or neurons, are unique because they do not form continuous layers or sheets like epithelial cells. Instead, each neuron remains a structurally distinct and separate unit, communicating with others through specialized junctions called synapses. While they work together in complex networks, they do not fuse or pack into a cohesive tissue layer like muscle or epithelial cells do in the body.

The structural independence of neurons is a key feature of the nervous system. This separation allows for precise and complex signaling across different parts of the body. While they may be bundled together in nerves, the individual cells remain distinct. Recognizing this difference is essential for understanding histology and how the nervous system is built differently from the more continuous tissues of the body.

85. (1) chondroitin
The extracellular matrix of cartilage is rich in proteoglycans, which are composed of proteins linked to glycosaminoglycans. Chondroitin sulfate is the primary polysaccharide found in these structures, providing the cartilage with its characteristic resilience and ability to resist compression. Ossein is the protein matrix of bone, while casein is a milk protein. Chondroitin is specifically associated with the pliable matrix produced by chondrocytes.

This polysaccharide is vital for the mechanical properties of cartilage. It helps the tissue absorb water, which allows it to act as a shock absorber at joints and other locations. Understanding the chemical components of the matrix is essential for grasping how cartilage functions and how it differs from the more mineralized matrix of bone. Chondroitin is a key marker for this tissue type.

86. (2) make a definite layer
Simple epithelium is defined by its organization into a single, definite layer of cells resting on a basement membrane. This single-layered arrangement is specialized for functions such as absorption, secretion, and filtration. While the cells within the layer are closely packed, they do not divide indiscriminately but are regulated to maintain the integrity and specific function of the tissue lining various organs and cavities.

The organization of cells into a clear, single layer is the hallmark of simple epithelium. This structure is found in areas where substances must pass through easily, such as the lungs or kidney tubules. Unlike stratified epithelium, which has multiple layers for protection, simple epithelium focuses on exchange. Recognizing this definite layering is fundamental for identifying and understanding the function of epithelial tissues in biology.

NODIA

CHAPTER 08
Cell The Unit of Life

2026 (RE-NEET)

1. The plastid that stores xanthophyll is known as:
(1) aleuroplast
(2) amyloplast
(3) chloroplast
(4) chromoplast

2026 (RE-NEET)

2. Mitochondrial inner membrane encloses:
(1) mucus
(2) aqueous humor
(3) matrix
(4) cytosol

2026 (RE-NEET)

3. Which of the following are characteristics of prokaryotic cells?
(a) Ribosomes made of 50S and 30S subunits;
(b) They can have plasmids;
(c) They contain mesosome;
(d) They have peroxisomes.
(1) (a), (b) and (d) only
(2) (a), (b) and (c) only
(3) (b) and (d) only
(4) (a) and (c) only

2026 (RE-NEET)

4. Smooth endoplasmic reticulum:
(1) is actively involved in protein synthesis
(2) is a site for the synthesis of carbohydrates
(3) has ribosomes attached to its surface
(4) is the major site for the synthesis of lipids

2026 (RE-NEET)

5. Cell theory was formulated by:
(1) Singer and Nicolson
(2) Antonie Von Leeuwenhoek
(3) Schleiden and Schwann
(4) Robert Brown

2026 (RE-NEET)

6. Match List-I with List-II:
List-I :
A. Cristae;
B. Cisternae;
C. Thylakoids;
D. Phospholipid.

List-II :
I. Flat membrane sacs in stroma of chloroplast,
II. Infoldings in mitochondria,
III. Cell membrane,
IV. Disc shaped sacs in Golgi apparatus)
Choose the correct answer from the options given below
(1) A-II, B-IV, C-III, D-I
(2) A-IV, B-III, C-I, D-II
(3) A-III, B-IV, C-I, D-II
(4) A-II, B-IV, C-I, D-III

2026 (RE-NEET)

7. Endomembrane system includes:
(1) mitochondria, chloroplast, peroxisomes and vacuole
(2) Golgi complex, chloroplast, peroxisomes and vacuole
(3) endoplasmic reticulum, Golgi complex, lysosomes and vacuole
(4) endoplasmic reticulum, chloroplast, peroxisomes and vacuole

2026 (CANCELLED)

8. Which one of the following is the site for active ribosomal RNA synthesis?
(1) Centrosome
(2) Chromatin
(3) Nucleolus
(4) Kinetochore

2026 (CANCELLED)

9. Non-membrane bound cell organelles found in both prokaryotic and eukaryotic cells are:
(1) Ribosomes
(2) Lysosomes
(3) Centrosomes
(4) Mitochondria

2026 (CANCELLED)

10. Choose the correct statements regarding cell organelles and their inclusions:
A. The endomembrane system includes Golgi complex, endoplasmic reticulum and mitochondria.
B. Rough endoplasmic reticulum bears ribosomes on its surface.
C. Both mitochondria and plastids have circular DNA.
D. A network of microtubules, microfilaments and intermediate filaments present in the

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92. (3) chondrin

The extracellular matrix of cartilage is composed of a firm, elastic substance known as chondrin. This protein-polysaccharide complex is produced and secreted by specialized cells called chondrocytes. Chondrin provides the cartilage with its characteristic flexibility and toughness, allowing it to act as a supportive framework and shock absorber in the body. Ossein is the corresponding protein found in bone matrix, rather than cartilage.

The properties of cartilage are largely due to the presence of chondrin in its matrix. This substance gives the tissue its pliable yet strong nature. Understanding the specific proteins and compounds that make up different tissues is a key part of histology. By recognizing chondrin as the primary matrix material in cartilage, we can better understand how this tissue functions in the skeleton.

93. (1) no cell product of epithelial cell

The basement membrane is a thin, non-cellular layer that anchors an epithelium to the underlying connective tissue. It is composed of the basal lamina, secreted by the overlying epithelial cells, and the reticular lamina, produced by the underlying connective tissue cells. Therefore, it is considered a product of the cells rather than being composed of cells itself. It provides structural support and acts as a filter.

This non-cellular structure is vital for the integrity of epithelial layers. It provides a surface for cell attachment and regulates the movement of molecules between the epithelium and the underlying tissue. Understanding that the basement membrane is a secretion of cells rather than a cellular layer itself is an important histological concept. It defines the boundary of all epithelial tissues in the body.

94. (1) Columnar

The stratum germinativum, also known as the stratum malpighii, is the innermost layer of the epidermis. It consists of a single row of cells that are primarily columnar or cuboidal in shape. These cells are characterized by their high mitotic activity, as they continuously divide to produce new skin cells. This layer serves as the foundation for skin regeneration and rests directly upon the basement membrane.

The tall, columnar shape of these cells provides the necessary volume for active cell division. As the primary source of new skin cells, the stratum germinativum is essential for the constant renewal of the epidermis. Understanding the epithelial type found in this layer helps in grasping the structure and growth of the skin. It is the living, active base that supports the protective outer layers.

95. (1) frontoparietal

In the skeletal system of a frog, the roof of the cranium, which protects the brain, is primarily formed by a pair of large, flat bones called the frontoparietals. These bones are the result of the fusion of the frontal and parietal bones found in other vertebrates. They provide a sturdy dorsal covering for the skull. Other bones like the parasphenoid form the floor of the cranium.

The skull of a frog is adapted for protection and streamlined movement. The frontoparietal bones are key structural elements that enclose the brain cavity from above. Knowing the names and locations of these bones is fundamental for studying amphibian osteology. This particular bone fusion is a characteristic feature that distinguishes the frog skull from those of many other vertebrate groups.

96. (2) hyoid apparatus

The tongue of a frog is a specialized muscular organ used for capturing prey. It is attached at its anterior end to the floor of the mouth, specifically to the cartilaginous and bony structure known as the hyoid apparatus. This attachment allows the posterior part of the tongue to be flipped out rapidly. The hyoid apparatus provides the necessary skeletal support for the tongue and its movement.

The unique way the frog's tongue is attached is essential for its feeding strategy. By being anchored at the front, the tongue can be extended much further and faster than a human tongue. This rapid motion is powered by muscles connected to the hyoid apparatus. Understanding this anatomical relationship is key to grasping how frogs successfully hunt for insects and other small prey.

97. (4) the opening in the auditory capsule which separates the middle ear from the internal ear.

The fenestra ovalis is a small, membrane-covered opening located in the wall of the auditory capsule of a frog. It serves as the interface between the middle ear cavity and the internal ear. Sound vibrations are transmitted from the tympanic membrane through the columella bone

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C.	George Palade	III.	Ribosomes
D.	Camillo Golgi	IV.	Nucleus

Choose the correct answer from the options given below.
(1) A-II, B-IV, C-III, D-I
(2) A-II, B-III, C-I, D-IV
(3) A-I, B-II, C-III, D-IV
(4) A-IV, B-II, C-III, D-I

RE-EXAM 2024

18. Match List-I with List-II.

	List-I		List-II
A	Metacentric chromosome	I	Chromosome has a terminal centromere
B	Sub-metacentric chromosome	II	Middle centromere forming two equal arms of chromosome
C	Acrocentric chromosome	III	Centromere is slightly away from the middle of chromosome resulting into two unequal arms
D	Telocentric chromosome	IV	Centromere is situated close to its end forming one extremely short and one very long arm

Choose the correct answer from the options given below.
(1) A-II, B-I, C-IV, D-III
(2) A-IV, B-I, C-II, D-III
(3) A-I, B-II, C-III, D-IV
(4) A-II, B-III, C-IV, D-I

RE-EXAM 2024

19. Match List-I with List-II.

	List-I		List-II
A.	F_1 particles	I.	Chromosomes
B.	Histones	II.	Cilia
C.	Axoneme	III.	Golgi apparatus
D.	Cisternae	IV.	Mitochondria

Choose the correct answer from the options given below.
(1) A-II, B-I, C-IV, D-III
(2) A-IV, B-I, C-II, D-III
(3) A-IV, B-I, C-III, D-II
(4) A-IV, B-III, C-I, D-II

RE-EXAM 2024

20. Given below are two statements.
Statement I : Concentrically arranged cisternae of Golgi complex are arranged near the nucleus with distinct convex cis or maturing and concave trans or forming face.
Statement II : A number of proteins are modified in the cisternae of Golgi complex before they are released from cis face.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

2024

21. Match List I with List II :

	List-I		List-II
A	Axoneme	I	Centriole
B	Cartwheel pattern	II	Cilia and flagella
C	Cristae	III	Chromosome
D	Satellite	IV	Mitochondria

Choose the correct answer from the options given below :
(1) A-IV, B-III, C-II, D-I
(2) A-IV, B-II, C-III, D-I
(3) A-II, B-IV, C-I, D-III
(4) A-II, B-I, C-IV, D-III

2024

22. Given below are two statements :
Statements I : Mitochondria and chloroplast both double membrane bound organelles.
Statements II : Inner membrane of mitochondria is relative less permeable, as compared chloroplast.
In the light of the above statements, choose the appropriate answer from the options given below.
(1) Both Statement I and Statement II are correct.
(2) Both Statement I and Statement II incorrect.
(3) Statement I is correct but Statement II incorrect.
(4) Statement I is incorrect but Statement II incorrect.

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Bone growth is a dynamic process of building and breaking down. Osteoblasts are the builders, creating the hard mineralized tissue, while chondroclasts clear the path by removing the temporary cartilage. This balance is essential for the proper development of the skeleton. Understanding these cell types and their roles is fundamental to grasping how the vertebrate body grows and maintains its structural support.

103. (4) moist skin.
Frogs possess numerous mucus-secreting glands in their skin. The primary function of this mucus is to keep the skin constantly moist. This moisture is essential for cutaneous respiration, as gas exchange can only occur through the skin when it is wet. A moist skin surface also helps in maintaining water balance and provides a slippery texture that can assist the frog in escaping from predators effectively.

The moist skin of a frog is a vital physiological adaptation for its dual lifestyle. Without this layer of mucus, the skin would dry out, and the frog would be unable to breathe properly. This mucus also serves as a protective barrier against certain pathogens. Understanding the role of skin secretions is fundamental for studying amphibian biology and how they manage their basic life processes.

104. (1) spindle-shaped, unbranched, nonstriated, uninucleate and involuntary.
Smooth muscle fibers are characterized by their spindle-shaped or fusiform appearance, with each cell being unbranched and containing a single, centrally located nucleus. These muscles are non-striated, meaning they lack the bands seen in skeletal and cardiac muscles. They operate under involuntary control. These fibers are primarily found in the walls of hollow organs, where they produce slow, sustained contractions for vital functions.

The structure of smooth muscle is perfectly suited for managing internal bodily processes. Its non-striated, single-nucleus cells provide the slow and steady movement needed for things like digestion and blood vessel regulation. Understanding these physical characteristics is essential for identifying different muscle types under a microscope and grasping how they are controlled by the autonomic nervous system to maintain homeostasis.

105. (3) Both A and R are true and R is correct explanation of A.
Periplaneta americana, the common cockroach, is well-known as a nocturnal and omnivorous household pest. It is active during the night and consumes a wide variety of organic substances, including human food and waste. Its role as a scavenger means it feeds on decaying matter and debris, which explains its omnivorous diet and its presence in human dwellings where such materials are abundant.

The behavior and diet of the cockroach are closely linked to its status as a pest. By acting as a scavenger, it can find food in almost any environment, especially those inhabited by humans. This ecological niche is what makes them so successful and difficult to control. Recognizing the relationship between their scavenging nature and their omnivorous diet is key to understanding their biology.

106. (1) Rana tigrina.
The Bullfrog of India is scientifically known as Rana tigrina, which is now often referred to as Hoplobatrachus tigerinus. It is the most common species of frog found in the Indian subcontinent. This large amphibian is known for its distinct yellowish-green color and its loud croaking sound. It inhabits various freshwater environments like ponds and marshes. Other species mentioned are bullfrogs from different regions.

Rana tigrina is a key species for biological study in India. Its large size and widespread presence make it a standard model for amphibian anatomy and physiology. Knowing its scientific name is essential for academic and research purposes. This frog plays a vital role in its ecosystem as both a predator and prey, contributing to the balance of local freshwater habitats.

107. (2) 4 pairs.
The circulatory system of an earthworm features specialized pulsating vessels that function as hearts. There are four pairs of these hearts in total. Two pairs are known as lateral hearts, located in segments 7 and 9. The other two pairs are lateral-oesophageal hearts, situated in segments 12 and 13. These structures ensure the rhythmic pumping of blood throughout the closed circulatory system.

Earthworms have a sophisticated circulatory system for their size. The presence of these eight hearts allows for efficient blood movement

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to the fenestra ovalis, which then passes these vibrations into the inner ear. This structure is crucial for auditory processing.

The transmission of sound in amphibians involves several specialized parts. The fenestra ovalis acts as a gateway for sound waves to enter the sensory part of the ear. Without this opening, the frog would not be able to hear environmental sounds. Understanding its location and role is essential for studying the sensory biology of frogs and how they communicate and detect threats in their surroundings.

98. (4) mesonephros.
The kidneys of an adult frog are classified as mesonephros. This type of kidney is characteristic of most adult amphibians and fishes. It develops from the middle part of the embryonic nephrogenic tissue. In contrast, the pronephros is the functional kidney in the tadpole stage, and the metanephros is the advanced kidney found in reptiles, birds, and mammals. The mesonephros in frogs efficiently filters nitrogenous wastes.

Kidney types reflect the evolutionary and developmental stages of vertebrates. In frogs, the transition from the larval pronephros to the adult mesonephros marks a significant change in their excretory system. Knowing that adult frogs have mesonephric kidneys is fundamental for understanding their physiology. This organ effectively manages the animal's internal environment by removing urea and maintaining water and salt balance.

99. (4) inner lining of cheeks.
Epithelial tissue consisting of thin, flat cells arranged edge-to-edge like tiles is known as squamous epithelium. In humans, this tissue is found lining various surfaces where protection or filtration is required. The inner lining of the cheeks is composed of stratified squamous epithelium, which provides a protective layer. Simple squamous epithelium is also found in the walls of alveoli and blood vessels, facilitating efficient exchange.

Squamous cells are adapted for surfaces that experience wear or need to allow quick passage of materials. In the mouth, multiple layers of these flat cells protect against food abrasion. In the lungs or blood vessels, a single layer allows for rapid diffusion. Understanding where these cells are located is a key part of histology and helps explain how different body surfaces are protected and maintained.

NODIA

100. (1) epidermal in origin and made of dead cells.
Hair is a characteristic feature of mammalian skin. Each hair is an epidermal derivative, meaning it originates from the invagination of the epidermis into the dermis. The visible part of the hair, the shaft, consists entirely of dead, keratinized cells that have been pushed away from the living root. Therefore, while hair grows from living tissue, the hair itself is composed of dead material and protein.

The process of hair growth involves the continuous production of cells at the follicle base. As these cells move upward, they become filled with keratin and die, forming the tough hair shaft. This epidermal origin is a fundamental concept in skin biology. Recognizing that hair is non-living tissue helps in understanding its structural properties and why it can be cut without causing pain.

101. (3) stratum malpighii/stratum germinativum
The layer of the skin responsible for continuous cell division and the production of new epidermal cells is the stratum germinativum, also called the stratum malpighii. This layer is located at the base of the epidermis. As cells in this layer divide, the older cells are pushed upward toward the surface, eventually becoming keratinized. This process ensures constant skin renewal and maintains the thickness of the protective outer layers.

Skin health relies on the activity of this foundational layer. By constantly creating new cells, the stratum germinativum replaces those lost to abrasion at the surface. This regenerative capacity is vital for the skin's role as a barrier. Understanding which layer is mitotically active is fundamental for studying the growth, repair, and overall structure of the vertebrate integumentary system.

102. (1) deposition of bony matter by osteoblasts and resorption by chondroclasts.
The formation of cartilage bones, also known as endochondral ossification, is a process where a cartilage model is replaced by bone. It involves the active deposition of new bony matrix by specialized cells called osteoblasts. Simultaneously, the original cartilage matrix is broken down and removed by cells known as chondroclasts. This coordinated activity allows for the gradual transformation of the skeletal framework into a mineralized structure.

and grasping how living tissue can be maintained within such a hard and mineralized skeletal framework.

113. (1) connective tissues.
Histamine-secreting cells, known as mast cells, are predominantly found within various connective tissues throughout the body. They are particularly abundant in the loose connective tissue surrounding blood vessels and in the skin and respiratory tract. When these mast cells are triggered, they release histamine, initiating inflammatory responses such as vasodilation. This localization allows for a rapid local reaction to potential threats or damage.

Connective tissue provides the perfect home for mast cells to stand guard against invaders. By being spread throughout the body's framework, they can respond quickly to any site of injury. This role in inflammation is a key part of the immune system's function. Understanding the distribution of these cells helps explain how the body coordinates its response to allergens and physical trauma.

114. (2) iron.
The red pigment found in the blood of vertebrates is haemoglobin, a complex protein responsible for transporting oxygen. At the core of each haem subunit is an atom of iron. This iron mineral is essential because it binds reversibly with oxygen molecules, allowing the blood to carry oxygen from the lungs to all the tissues. Without sufficient iron, the production of haemoglobin is impaired.

Iron is the key element that makes vertebrate respiration possible. Its ability to hold onto and release oxygen is what fuels the entire body. This requirement for iron is why it is such an important part of the diet. Understanding the chemical structure of haemoglobin and the role of iron is fundamental for grasping how the circulatory and respiratory systems work together.

115. (1) useful.
Earthworms are generally regarded as highly useful organisms due to their significant positive impact on soil ecology. Their burrowing activities enhance soil aeration and drainage, while their feeding habits facilitate the decomposition of organic matter. The resulting worm castings enrich the soil with vital nutrients, improving fertility for plant growth. Their overall ecological contribution to nutrient cycling and soil structure makes them beneficial.

The many benefits of earthworms far outweigh any minor inconveniences they might cause. By improving the quality of the soil, they support entire food webs and help humans grow food more effectively. Their presence is a sign of a healthy ecosystem. Recognizing their value is important for both environmental science and sustainable farming, highlighting the role of small organisms in maintaining global health.

116. (3) dorsal surface.
Earthworms do not have complex eyes, but they possess simple photoreceptors that allow them to detect light intensity. These sensory structures are primarily distributed on the dorsal surface of the body, particularly concentrated toward the anterior end. By sensing light on their dorsal side, earthworms can stay underground during the day and emerge at night, helping them avoid harmful ultraviolet radiation and desiccation.

Being sensitive to light is a vital survival trait for earthworms. Since they lack protective skin and are prone to drying out, staying in the dark is essential. These dorsal photoreceptors act as a simple but effective early warning system. Understanding how and where they sense light helps explain their nocturnal behavior and how they navigate their environment to stay safe and healthy.

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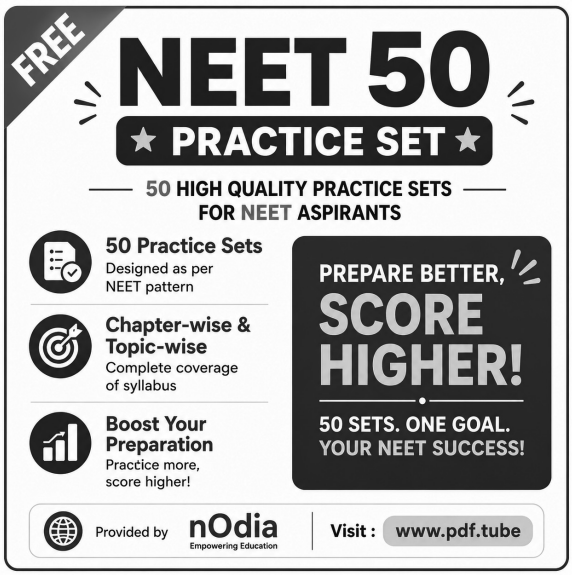

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87. (1) osmoregulation
In Pheretima, the enteronephric nephridia, which include the septal and pharyngeal nephridia, discharge their waste products into the lumen of the alimentary canal. This arrangement allows for the reabsorption of water from the excretory fluid before it is expelled. Consequently, the primary function of these nephridia is osmoregulation, helping the earthworm conserve vital water. While they also excrete wastes, water conservation is key.

Osmoregulation is a critical physiological process for earthworms living in soil. By discharging waste into the gut, they can effectively recycle water, which is a major survival adaptation. This enteronephric system is a specialized feature of certain annelids. Understanding how these organs contribute to water balance is fundamental for studying the environmental adaptations and waste management strategies of invertebrates like Pheretima.

88. (1) Will become flexible
When a bone is placed in dilute hydrochloric acid, the acid reacts with and dissolves the inorganic mineral salts, primarily calcium phosphate and calcium carbonate. This process, known as decalcification, leaves behind the organic matrix, which consists mainly of collagen fibers. Without the rigid mineral component, the bone loses its hardness and strength, becoming soft and flexible enough to be easily bent or tied.

The rigidity of bone comes from its mineral content, while its flexibility comes from the protein matrix. Removing the minerals through acid treatment reveals the underlying flexible structure. This experiment is a classic way to demonstrate the two main components of bone tissue. Understanding how these parts work together is essential for grasping the biomechanics and structural integrity of the vertebrate skeletal system.

89. (3) modified yellow elastic fibrous tissue
Ligaments are specialized connective tissues that primarily serve to connect one bone to another at a joint. They are composed of modified yellow elastic fibrous tissue, which contains a high proportion of elastin fibers along with some collagen. This composition allows ligaments to be strong yet elastic, providing the necessary flexibility for joint movement while maintaining stability. They differ from tendons made of white tissue.

The presence of elastin makes ligaments ideally suited for their role in holding bones together. They must be able to stretch during movement and then return to their original length. This elastic property is vital for joint function and preventing injury. Recognizing the difference between yellow elastic tissue in ligaments and white fibrous tissue in tendons is a fundamental concept in musculoskeletal anatomy.

90. (2) modified white fibrous tissue
Tendons are dense regular connective tissues that attach skeletal muscles to bones. They are composed of modified white fibrous tissue, which is characterized by densely packed, parallel bundles of collagen fibers. This structure provides exceptional tensile strength and very limited elasticity, ensuring that the force generated by muscle contraction is efficiently transmitted to the bone. This is distinct from the yellow elastic tissue.

Collagen is the key component that gives tendons their immense strength. Because they must withstand the pull of powerful muscles, they are built for durability rather than stretching. This white fibrous composition is a specialized adaptation for mechanical force transmission. Understanding the makeup of tendons is essential for grasping how muscles and bones work together to create movement in the body.

91. (2) mast cells.
In mammals, histamine is a key chemical mediator of inflammation and allergic responses, and it is primarily secreted by mast cells. These cells are found throughout the connective tissues of the body, particularly near blood vessels. When mast cells encounter an allergen or tissue damage, they release their stored granules of histamine, causing local vasodilation and increased capillary permeability. Other cells have different roles.

Mast cells are the front line of the inflammatory response. By releasing histamine, they signal for other immune cells to arrive and increase blood flow to the affected area. This is a vital part of the body's defense mechanism. Knowing that mast cells are the source of histamine helps in understanding various medical conditions, including allergies and the normal healing process after an injury.

NODIA

cytoplasm is called cytoskeleton.
E. Mitochondrion is a single membrane-bound structure.
(1) A and B only
(2) A, B and C only
(3) C, D and E only
(4) B, C and D only

2026 (CANCELLED)

11. Select the correct statements regarding cell membrane in eukaryotic cell:
A. Membrane of human RBCs has approximately 52% protein.
B. Major phospholipids are arranged in a bilayer.
C. Extensions of the plasma membrane into the cell form mesosomes.
D. Tails towards the inner part of lipids are hydrophobic and thus protected from aqueous medium.
E. Glycocalyx is present on the outer surface of the plasma membrane.
(1) C, D and E only
(2) B, C and E only
(3) A, B and D only
(4) A, C and E only

2025

12. A specialised membranous structure in a prokaryotic cell which helps in cell wall formation, DNA replication and respiration is
(1) cristae
(2) endoplasmic reticulum
(3) mesosome
(4) chromatophores.

2025

13. Given below are two statements.
One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The primary function of the Golgi apparatus is to package the materials made by the endoplasmic reticulum and deliver it to intracellular targets and outside the cell.
Reason (R): Vesicles containing materials made by the endoplasmic reticulum fuse with the cis face of the Golgi apparatus, and they are modified and released from the trans face of the Golgi apparatus.
In the light of the above statements, choose the correct answer from the options given below:
(1) A is true but R is false.
(2) A is false but R is true.
(3) Both A and R are true and R is the correct explanation of A.
(4) Both A and R are true but R is not the correct explanation of A.

2025

14. From the statements given below choose the correct option.
A. The eukaryotic ribosomes are 80S and prokaryotic ribosomes are 70S.
B. Each ribosome has two sub-units.
C. The two sub-units of 80S ribosome are 60S and 40S while that of 70S are 50S and 30S.
D. The two sub-units of 80S ribosome are 60S and 20S and that of 70S are 50S and 20S.
E. The two sub-units of 80S are 60S and 30S and that of 70S are 50S and 30S.
(1) A, B, E are true.
(2) B, D, E are true.
(3) A, B, C are true.
(4) A, B, D are true.

2025

15. Match List-I with List-II.

	List-I		List-II
A.	Centromere	I.	Mitochondrion
B.	Cilium	II.	Cell division
C.	Cristae	III.	Cell movement
D.	Cell membrane	IV.	Phospholipid Bilayer

Choose the correct answer from the options given below:
(1) A-IV, B-II, C-III, D-I
(2) A-II, B-III, C-I, D-IV
(3) A-I, B-II, C-III, D-IV
(4) A-II, B-I, C-IV, D-III

RE-EXAM 2024

16. Mesosome in a cell is a
(1) membrane bound vesicular structure
(2) chain of many ribosomes attached to a single mRNA
(3) special structure formed by extension of plasma membrane
(4) medium sized chromosome.

RE-EXAM 2024

17. Match List-I with List-II.

	List-I		List-II
A.	Flemming	I.	Disc shaped sacs or cisternae near cell nucleus
B.	Robert Brown	II.	Chromatin

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through the body segments. This closed system is a major evolutionary advancement over open systems found in some other invertebrates. Understanding the number and location of these hearts is a fundamental part of annelid anatomy and their internal physiological organization.

108. (1) anal styles in male.
Male and female cockroaches can be easily distinguished externally by observing the structures on their posterior abdominal segments. Males possess a pair of short, unjointed, thread-like structures called anal styles on the ninth sternum. Females lack these styles completely. While both sexes have jointed anal cerci on the tenth segment, the anal styles are the unique feature used to identify males in the species.

Identifying the sex of a cockroach is a basic skill in entomology. The anal styles are a reliable and easy-to-see marker for males. This morphological difference is an example of sexual dimorphism, where males and females have distinct physical traits beyond their reproductive organs. Knowing this feature is important for sorting and studying cockroach populations in both laboratory and field settings.

109. (4) red with haemoglobin in plasma.
The blood of the earthworm Pheretima is red due to the presence of the respiratory pigment haemoglobin. Unlike in vertebrates, where haemoglobin is contained within red blood cells, in earthworms, it is dissolved directly in the blood plasma. The blood cells found in earthworms are colorless and nucleated. This arrangement allows for the efficient transport of oxygen through the worm closed circulatory system.

The location of haemoglobin in the plasma is a key distinction between earthworms and vertebrates. Despite this difference, the function remains the same: carrying oxygen to tissues. This physiological trait is an important adaptation for the earthworm's lifestyle. Understanding where respiratory pigments are found in different animals is a fundamental part of comparative physiology and the study of circulatory systems.

110. (2) they make the soil porous, leave their castings and take organic debris in the soil.
Pheretima posthuma is highly beneficial to agriculture and soil health. By burrowing through the earth, these worms make the soil more porous, which improves aeration and water infiltration. They consume soil and organic debris, and their excreted castings are rich in nutrients, serving as a natural fertilizer. This continuous processing of organic matter significantly enhances the productivity and health of the land.

Earthworms are essential for maintaining fertile soil. Their activities help mix the earth and break down plant matter, which releases nutrients back into the ground. This natural tilling and fertilization process is why they are often called "nature's plowmen." Understanding the ecological role of earthworms is vital for appreciating their importance in both natural ecosystems and human-managed agricultural systems.

NODIA

111. (2) hasten their metamorphosis.
Thyroxine is a hormone produced by the thyroid gland that plays a critical role in the metamorphosis of amphibians. In frog tadpoles, the presence of thyroxine or its essential component, iodine, in the water triggers and accelerates the transition from the aquatic larval stage to the adult form. This process involves significant physiological and morphological changes, such as the development of lungs and limbs.

The control of metamorphosis by hormones is a classic example of physiological regulation. By adding thyroxine, the developmental clock is sped up, forcing the tadpole to mature faster. This experiment demonstrates the powerful effect of hormones on growth and development. Knowing the role of iodine and thyroxine is fundamental for understanding how frogs and other amphibians transition between their different life stages.

112. (1) humerus.
Haversian canals are a fundamental structural feature of compact bone in mammals. They are longitudinal channels that house blood vessels and nerves, providing nourishment to the bone cells. These canals are found in long bones, such as the humerus of the arm. Other bones also contain Haversian systems if they are composed of compact bone. The presence of these canals is a characteristic diagnostic feature.

The Haversian system is essential for maintaining the health of rigid bone tissue. Because bone is dense, nutrients must be delivered through these specialized channels. Each canal is surrounded by concentric layers of bone matrix. Understanding this microscopic structure is fundamental for identifying mammalian bone

2024

23. Match List I with List II.

	List-I		List-II
A.	Nucleolus	I.	Site of formation of glycolipid
B.	Centriole	II.	Organisation like the cartwheel
C.	Leucoplasts	III.	Site for active ribosomal RNA synthesis
D.	Golgi apparatus	IV.	For storing nutrients

Choose the correct answer from the options given below.
(1) A-III, B-II, C-IV, D-I
(2) A-II, B-III, C-I, D-IV
(3) A-III, B-IV, C-II, D-I
(4) A-I, B-II, C-III, D-IV

2024

24. The DNA present in chloroplast is
(1) linear, double stranded
(2) circular, double stranded
(3) linear, single stranded
(4) circular, single stranded.

Manipur NEET 2023

25. Given below are two statements.
Statement I : In bacteria, the mesosomes are formed by the extensions of plasma membrane.
Statement II : The mesosomes, in bacteria, help in DNA replication and cell wall formation.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

Manipur NEET 2023

26. Which of the following statements are correct with respect of Golgi apparatus?
(A) It is the important site of formation of glycoprotein and glycolipids.
(B) It produced cellular energy in from of ATP.
(C) It modifies the protein synthesised by ribosomes on ER.
(D) It facilities the transport of ions.
(E) It provides mechanical support.
Choose the most appropriate answer from the options given below.
(1) (B) and (C) only
(2) (A) and (C) only
(3) (A) and (D) only
(4) (D) and (E) only

2023

27. Which of the following functions is carried out by cytoskeleton in a cell?
(1) Motility
(2) Transportation
(3) Nuclear division
(4) Protein synthesis

2023

28. Which of the following are not considered as the part of endomembrane system?
A. Mitochondria
B. Endoplasmic Reticulum
C. Chloroplasts
D. Golgi complex
E. Peroxisomes
Choose the most appropriate answer from the options given below.
(1) A and D only
(2) A, D and E only
(3) B and D only
(4) A, C and E only

2023

29. How many different proteins does the ribosome consist of?
(1) 40 (2) 20
(3) 80 (4) 60

2022

30. Match list-I with list-II.

	Column I		Column II
(A)	Metacentric chromosome	(i)	Centromere situated close to the end forming one extremely short and one very long arm
(B)	Acrocentric chromosome	(ii)	Centromere at the terminal end
(C)	Sub-metacentric	(iii)	Centromere in the middle forming two equal arms of chromosomes

NODIA

NEET-I 2016

52. Mitochondria and chloroplast are
(A) semi-autonomous organelles
(B) formed by division of pre-existing organelles and they contain DNA but lack protein synthesising machinery.
Which one of the following options is correct?
(1) (A) is true but (B) is false.
(2) Both (A) and (B) are false.
(3) Both (A) and (B) are correct.
(4) (B) is true but (A) is false.

NEET-I 2016

53. Microtubules are the constituents of
(1) centrioles, spindle fibres and chromatin
(2) centrosome, nucleosome and centrioles
(3) cilia, flagella and peroxisomes
(4) spindle fibres, centrioles and cilia.

NEET-I 2016

54. Which one of the following cell organelles is enclosed by a single membrane?
(1) Lysosomes
(2) Nuclei
(3) Mitochondria
(4) Chloroplasts

NEET-I 2016

55. Water soluble pigments found in plant cell vacuoles are
(1) carotenoids
(2) anthocyanins
(3) xantophylls
(4) chlorophylls.

2015

56. Which of the following structures is not found in a prokaryotic cell?
(1) Mesosome
(2) Plasma membrane
(3) Nuclear envelope
(4) Ribosome

2015

57. The structures that help some bacteria to attach to rocks and/or host tissues are
(1) mesosomes
(2) holdfast
(3) rhizoids
(4) fimbriae.

2015 Cancelled

58. Which one of the following is not an inclusion body found in prokaryotes?
(1) Glycogen granule
(2) Polysome
(3) Phosphate granule
(4) Cyanophycean granule

2015

59. Match the columns and identify the correct option.

	Column I		Column II
A.	Thylakoids	(i)	Disc-shaped sacs in Golgi apparatus
B.	Cristae	(ii)	Condensed structure of DNA
C.	Cisternae	(iii)	Flat membranous sacs in stroma
D.	Chromatin	(iv)	Infoldings in mitochondria

(1) A-(iii), B-(i), C-(iv), D-(ii)
(2) A-(iii), B-(iv), C-(ii), D-(i)
(3) A-(iv), B-(iii), C-(i), D-(ii)
(4) A-(iii), B-(iv), C-(i), D-(ii)

2015

60. Cellular organelles with membranes are
(1) endoplasmic reticulum, ribosomes and nuclei
(2) lysosomes, Golgi apparatus and mitochondria
(3) nuclei, ribosomes and mitochondria
(4) chromosomes, ribosomes and endoplasmic reticulum.

2015

61. Which of the following are not membrane bound?
(1) Lysosomes (2) Mesosomes
(3) Vacuoles (4) Ribosomes

2015 Cancelled

62. DNA is not present in
(1) nucleus (2) mitochondria
(3) chloroplast (4) ribosomes.

2015 Cancelled

63. Nuclear envelope is a derivative of
(1) microtubules
(2) rough endoplasmic reticulum
(3) smooth endoplasmic reticulum
(4) membrane of Golgi complex.

2015 Cancelled

64. The structures that are formed by stacking of organised flattened membranous sacs in the chloroplasts are
(1) stroma lamellae
(2) stroma
(3) cristae
(4) grana.

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2019

40. Which of the following statements regarding mitochondria is incorrect?
(1) Mitochondrial matrix contains single circular DNA molecule and ribosomes.
(2) Outer membrane is permeable to monomers of carbohydrates, fats and proteins.
(3) Enzymes of electron transport are embedded in outer membrane.
(4) Inner membrane is convoluted with infoldings.

2019

41. The shorter and longer arms of a submetacentric chromosome are referred to as
(1) m-arm and n-arm respectively
(2) s-arm and l-arm respectively
(3) p-arm and q-arm respectively
(4) q-arm and p-arm respectively.

2019

42. Which of the following pairs of organelles does not contain DNA?
(1) Nuclear envelope and Mitochondria
(2) Mitochondria and Lysosome
(3) Chloroplast and Vacuoles
(4) Lysosomes and Vacuoles

Odisha NEET 2019

43. Match the column I with column II.

	Column I		Column II
A.	Golgi apparatus	i.	Synthesis of protein
B.	Lysosomes	ii.	Trap waste and excretory products
C.	Vacuoles	iii.	Formation of glycoproteins and glycolipids
D.	Ribosomes	iv.	Digesting biomolecules

Choose the right match from options given below.
(1) A-(iii), B-(iv), C-(ii), D-(i)
(2) A-(iv), B-(iii), C-(i), D-(ii)
(3) A-(iii), B-(ii), C-(iv), D-(i)
(4) A-(i), B-(ii), C-(iv), D-(iii)

2018

44. Which of the following is true for nucleolus?
(1) Larger nucleoli are present in dividing cells.
(2) It is a membrane-bound structure.
(3) It takes part in spindle formation.
(4) It is a site for active ribosomal RNA synthesis.

2018

45. The Golgi complex participates in
(1) fatty acid breakdown
(2) formation of secretory vesicles
(3) respiration in bacteria
(4) activation of amino acid.

2018

46. Which of the following events does not occur in rough endoplasmic reticulum?
(1) Protein folding
(2) Protein glycosylation
(3) Cleavage of signal peptide
(4) Phospholipid synthesis

2018

47. Select the incorrect match.
(1) Lampbrush chromosomes - Diplotene bivalents
(2) Allosomes - Sex chromosomes
(3) Sub-metacentric chromosomes - L-shaped chromosomes
(4) Polytene chromosomes - Oocytes of amphibians

2017

48. Which of the following cell organelles is responsible for extracting energy from carbohydrates to form ATP?
(1) Ribosome
(2) Chloroplast
(3) Mitochondrion
(4) Lysosome

NODIA

NEET-II 2016

49. Select the wrong statement.
(1) Bacterial cell wall is made up of peptidoglycan.
(2) Pili and fimbriae are mainly involved in motility of bacterial cells.
(3) Cyanobacteria lack flagellated cells.
(4) Mycoplasma is a wall-less microorganism.

NEET-II 2016

50. Select the mismatch.
(1) Gas vacuoles - Green bacteria
(2) Large central vacuoles - Animal cells
(3) Protists - Eukaryotes
(4) Methanogens - Prokaryotes

NEET-II 2016

51. A cell organelle containing hydrolytic enzymes is
(1) lysosome
(2) microsome
(3) ribosome
(4) mesosome.

2013

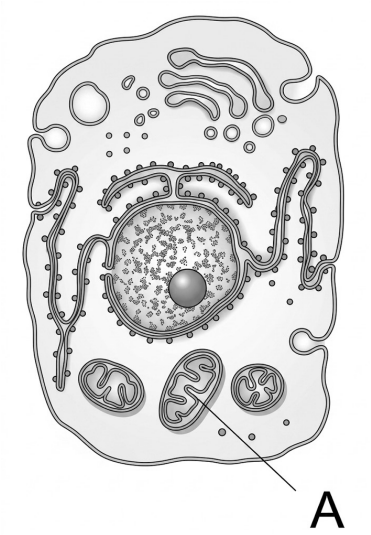
76. A major site for synthesis of lipids is
(1) symplast
(2) nucleoplasm
(3) RER
(4) SER

Karnataka NEET 2013

77. Which of the following types of plastid does not contain stored food material?
(1) Chromoplasts
(2) Elaioplasts
(3) Aleuroplasts
(4) Amyloplasts

Karnataka NEET 2013

78. Select the alternative giving correct identification and function of the organelle 'A' in the diagram.



(1) Mitochondria - Produce cellular energy in the form of ATP
(2) Golgi body - Provides packaging material
(3) Lysosomes - Secrete hydrolytic enzymes
(4) Endoplasmic reticulum - Synthesis of lipids

2012

79. Select the correct statement from the following regarding cell membrane.
(1) Na^+ and K^+ ions move across cell membrane by passive transport.
(2) Proteins make up 60 to 70% of the cell membrane.
(3) Lipids are arranged in a bilayer with polar heads towards the inner part.
(4) Fluid mosaic model of cell membrane was proposed by Singer and Nicolson.

2012

80. What is true about ribosomes?
(1) The prokaryotic ribosomes are 80S, where "S" stands for sedimentation coefficient.
(2) These are composed of ribonucleic acid and proteins.
(3) These are found only in eukaryotic cells.
(4) These are self-splicing introns of some RNAs.

2012

81. Which one of the following does not differ in E.coli and Chlamydomonas?
(1) Ribosomes
(2) Chromosomal organization
(3) Cell wall
(4) Cell membrane

Mains 2012

82. Which one of the following cellular parts is correctly described?
(1) Thylakoids - flattened membranous sacs forming the grana of chloroplasts
(2) Centrioles - sites for active RNA synthesis
(3) Ribosomes - those on chloroplasts are larger (80S) while those in the cytoplasm are smaller (70S)
(4) Lysosomes - optimally active at a pH of about 8.5

Mains 2012

83. Which one of the following structures is an organelle within an organelle?
(1) Ribosome
(2) Peroxisome
(3) ER
(4) Mesosome

2011

84. Peptide synthesis inside a cell takes place in
(1) chloroplast
(2) mitochondria
(3) chromoplast
(4) ribosomes.

2011

85. Important site for formation of glycoproteins and glycolipids is
(1) vacuole
(2) Golgi apparatus
(3) plastid
(4) lysosome.

Mains 2011

86. Which one of the following is not considered as a part of the endomembrane system?
(1) Golgi complex

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2015 Cancelled

65. Select the correct matching in the following pairs.
(1) Rough ER - Synthesis of glycogen
(2) Rough ER - Oxidation of fatty acids
(3) Smooth ER - Oxidation of phospholipids
(4) Smooth ER - Synthesis of lipids

2015 Cancelled

66. The chromosomes in which centromere is situated close to one end are
(1) telocentric
(2) sub-metacentric
(3) metacentric
(4) acrocentric.

2014

67. Which structures perform the function of mitochondria in bacteria?
(1) Nucleoid (2) Ribosomes
(3) Cell wall (4) Mesosomes

2014

68. The motile bacteria are able to move by
(1) fimbriae (2) flagella
(3) cilia (4) pili.

2014

69. The solid linear cytoskeletal elements having a diameter of 6 nm and made up of a single type of monomer are known as
(1) microtubules
(2) microfilaments
(3) intermediate filaments
(4) lamins.

2014

70. The osmotic expansion of a cell kept in water is chiefly regulated by
(1) mitochondria
(2) vacuoles
(3) plastids
(4) ribosomes.

2014

71. Match the following and select the correct answer.

	List-I		Column II
A.	Centriole	(i)	Infoldings in mitochondria
B.	Chlorophyll	(ii)	Thylakoids
C.	Cristae	(iii)	Nucleic acids
D.	Ribozymes	(iv)	Basal body of cilia

(1) A-(iv); B-(ii); C-(i); D-(iii)
(2) A-(i); B-(ii); C-(iv); D-(iii)
(3) A-(i); B-(iii); C-(ii); D-(iv)
(4) A-(iv); B-(iii); C-(i); D-(ii)

Karnataka NEET 2013

72. Why is a capsule advantageous to a bacterium?
(1) It protects the bacterium from desiccation.
(2) It provides means of locomotion.
(3) It allows bacterium to "hide" from host's immune system.
(4) It allows the bacterium to attach to the surface.

NODIA

Karnataka NEET 2013

73. The term 'glycocalyx' is used for
(1) a layer present between cell wall and membrane of bacteria
(2) cell wall of bacteria
(3) bacterial cell glyco-engineered to possess N-glycosylated proteins
(4) a layer surrounding the cell wall of bacteria.

2013

74. The Golgi complex plays a major role
(1) as energy transferring organelles
(2) in post translational modification of proteins and glycosylation of lipids
(3) in trapping the light and transforming it into chemical energy
(4) in digesting proteins and carbohydrates.

2013

75. Which one of the following organelle in the figure correctly matches with its function?

(1) Golgi apparatus, formation of glycolipids
(2) Rough endoplasmic reticulum, protein synthesis
(3) Rough endoplasmic reticulum, formation of glycoproteins
(4) Golgi apparatus, protein synthesis

2009

94. Middle lamella is composed mainly of
(1) muramic acid
(2) calcium pectate
(3) phosphoglycerides
(4) hemicellulose.

2009

95. Cytoskeleton is made up of
(1) callose deposits
(2) cellulosic microfibrils
(3) proteinaceous filaments
(4) calcium carbonate granules.

2009

96. Plasmodesmata are
(1) locomotory structures
(2) membranes connecting the nucleus with plasmalemma
(3) connections between adjacent cells
(4) lignified cemented layers between cells.

2008

97. In germinating seeds, fatty acids are degraded exclusively in the
(1) peroxisomes (2) mitochondria
(3) proplastids (4) glyoxysomes.

2008

98. Vacuole in a plant cell
(1) lacks membrane and contains air
(2) lacks membrane and contains water and excretory substances
(3) is membrane-bound and contains storage proteins and lipids
(4) is membrane-bound and contains water and excretory substances.

2008

99. Keeping in view the 'fluid mosaic model' for the structure of cell membrane, which one of the following statement is correct with respect to the movements of lipids and proteins from one lipid monolayer to the other (described as flip-flop movement)?
(1) While proteins can flip-flop, lipids can not
(2) Neither lipids, nor proteins can flip-flop
(3) Both lipids and proteins can flip-flop
(4) While lipids can rarely flip-flop, proteins cannot.

2007

100. Which one of the following is not a constituent of cell membrane?
(1) Glycolipids
(2) Proline
(3) Phospholipids
(4) Cholesterol

2007

101. Select the wrong statement from the following.
(1) Both chloroplasts and mitochondria have an internal compartment, the thylakoid space bounded by the thylakoid membrane.
(2) Both chloroplasts and mitochondria contain DNA.
(3) The chloroplasts are generally much larger than mitochondria.
(4) Both chloroplasts and mitochondria contain an inner and an outer membrane.

2006

102. A major breakthrough in the studies of cells came with the development of electron microscope. This is because
(1) the electron microscope is more powerful than the light microscope as it uses a beam of electrons which has wavelength much longer than that of photons
(2) the resolving power of the electron microscope is much higher than that of the light microscope
(3) the resolving power of the electron microscope is 200 - 350 nm as compared to 0.1 - 0.2 nm for the light microscope
(4) electron beam can pass through thick materials, whereas light microscopy requires thin sections.

2006

103. Which of the following statements regarding mitochondrial membrane is not correct ?
(1) The outer membrane resembles a sieve.
(2) The outer membrane is permeable to all kinds of molecules.
(3) The enzymes of the electron transfer chain are embedded in the outer membrane.
(4) The inner membrane is highly convoluted forming a series of infoldings.

2006

104. Which of the following statements regarding cilia is not correct ?
(1) Cilia contain an outer ring of nine doublet microtubules surrounding two singlet microtubules.
(2) The organised beating of cilia is controlled by fluxes of Ca^{2+} across the membrane.
(3) Cilia are hair-like cellular appendages.
(4) Microtubules of cilia are composed of tubulin.

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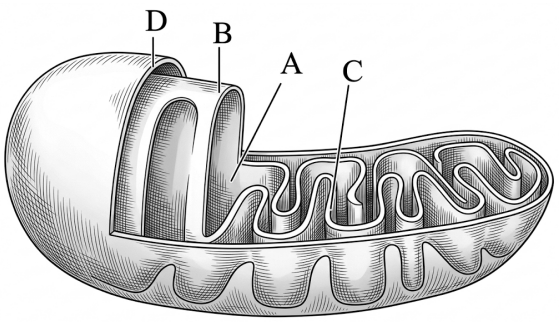
(2) Peroxisome
(3) Vacuole
(4) Lysosome

Mains 2011

87. The figure below shows the structure of a mitochondrion with its four parts labelled A, B, C and D. Select the part correctly matched with its function.



(1) D (outer membrane) - gives rise to inner membrane by splitting
(2) B (inner membrane) - forms infoldings called cristae
(3) C (crista) - possesses single circular DNA molecule and ribosomes
(4) A (matrix) - major site for respiratory chain enzymes

2010

88. The plasma membrane consists mainly of
(1) phospholipids embedded in a protein bilayer
(2) proteins embedded in a phospholipid bilayer
(3) proteins embedded in a polymer of glucose molecules
(4) proteins embedded in a carbohydrate bilayer.

2010

89. The main area of various types of activities of a cell is
(1) plasma membrane
(2) mitochondrion
(3) cytoplasm
(4) nucleus.

2010

90. Which one of the following has its own DNA?
(1) Mitochondria
(2) Dictyosome
(3) Lysosome
(4) Peroxisome

2010

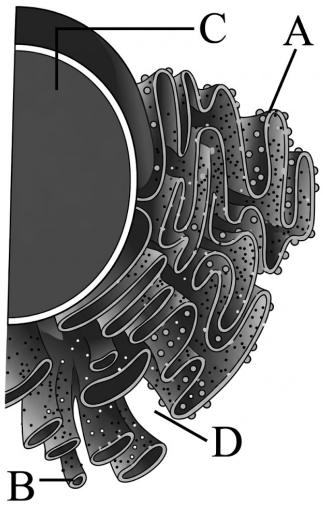
91. Which one of the following structures between two adjacent cells is an effective transport pathway?
(1) Plasmodesmata
(2) Plastoquinones
(3) Endoplasmic reticulum
(4) Plasmalemma

Mains 2010

92. An elaborate network of filamentous proteinaceous structures present in the cytoplasm which helps in the maintenance of cell shape is called
(1) thylakoid
(2) endoplasmic reticulum
(3) plasmalemma
(4) cytoskeleton.

Mains 2010

93. Identify the components labelled A, B, C and D in the diagram below from the list (i) to (viii) given along with components :



(i) Cristae of mitochondria
(ii) Inner membrane of mitochondria
(iii) Cytoplasm
(iv) Smooth endoplasmic reticulum
(v) Rough endoplasmic reticulum
(vi) Mitochondrial matrix
(vii) Cell vacuole
(viii) Nucleus
The correct components are:
(1) A-(v); B-(iv); C-(viii); D-(iii)
(2) A-(i); B-(iv); C-(viii); D-(vi)
(3) A-(vi); B-(v); C-(iv); D-(vii)
(4) A-(v); B-(i); C-(iii); D-(ii)

NODIA

(D)	Telocentric chromosome	(iv)	Centromere slightly away from the middle forming one shorter arm and one longer arm

Choose the correct answer from the options given below:
(1) (A)-(iii), (B)-(i), (C)-(iv), (D)-(ii)
(2) (A)-(i), (B)-(iii), (C)-(ii), (D)-(iv)
(3) (A)-(ii), (B)-(iii), (C)-(iv), (D)-(i)
(4) (A)-(i), (B)-(ii), (C)-(iii), (D)-(iv)

2022

31. Which of the following statements with respect to endoplasmic reticulum is incorrect?
(1) RER has ribosomes attached to ER
(2) SER is devoid of ribosomes
(3) In prokaryotes only RER are present
(4) SER are the sites for lipid synthesis

2021

32. Which of the following is an incorrect statement?
(1) Nuclear pores act as passages for proteins and RNA molecules in both directions between nucleus and cytoplasm.
(2) Mature sieve tube elements possess a conspicuous nucleus and usual cytoplasmic organelles.
(3) Microbodies are present both in plant and animal cells.
(4) The perinuclear space forms a barrier between the materials present inside the nucleus and that of the cytoplasm.

2021

33. Match List-I with List-II.

	List-I		List-II
(p)	Cristae	(i)	Primary constriction in chromosome
(q)	Thylakoids	(ii)	Disc-shaped sacs in Golgi apparatus
(r)	Centromere	(iii)	Infoldings in mitochondria
(s)	Cisternae	(iv)	Flattened membranous sacs in stroma of plastids

Choose the correct answer from the options given below.
(1) (p)-(ii); (q)-(iii); (r)-(iv); (s)-(i)
(2) (p)-(iv); (q)-(iii); (r)-(ii); (s)-(i)
(3) (p)-(i); (q)-(iv); (r)-(iii); (s)-(ii)
(4) (p)-(iii); (q)-(iv); (r)-(i); (s)-(ii)

2021

34. When the centromere is situated in the middle of two equal arms of chromosomes, the chromosome is referred as
(1) acrocentric
(2) metacentric
(3) telocentric
(4) sub-metacentric.

2021

35. The organelles that are included in the endomembrane system are
(1) Golgi complex, endoplasmic reticulum, mitochondria and lysosomes
(2) Endoplasmic reticulum, mitochondria, ribosomes and lysosomes
(3) Endoplasmic reticulum, Golgi complex, lysosomes and vacuoles
(4) Golgi complex, mitochondria, ribosomes and lysosomes.

2020

36. Which of the following statements about inclusion bodies is incorrect?
(1) They are not bound by any membrane.
(2) These are involved in ingestion of food particles.
(3) They lie free in the cytoplasm.
(4) These represent reserve material in cytoplasm.

2020

37. Which is the important site of formation of glycoproteins and glycolipids in eukaryotic cells?
(1) Endoplasmic reticulum
(2) Peroxisomes
(3) Golgi bodies
(4) Polysomes

2019

38. The concept of "Omnis cellula-e-cellula" regarding cell division was first proposed by
(1) Aristotle
(2) Rudolf Virchow
(3) Theodore Schwann
(4) Schleiden.

2019

39. Which of the following statements is not correct?
(1) Lysosomes are formed by the process of packaging in the endoplasmic reticulum.
(2) Lysosomes have numerous hydrolytic enzymes.
(3) The hydrolytic enzymes of lysosomes are active under acidic pH.
(4) Lysosomes are membrane-bound structures.

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2005

105. A student wishes to study the cell structure under a light microscope having 10X eyepiece and 45X objective. He should illuminate the object by which one of the following colours of light so as to get the best possible resolution?
(1) Blue (2) Green
(3) Yellow (4) Red

2005

106. Chlorophyll in chloroplasts is located in
(1) grana
(2) pyrenoid
(3) stroma
(4) both grana and stroma.

2005

107. According to widely accepted "fluid mosaic model" cell membranes are semi-fluid, where lipids and integral proteins can diffuse randomly. In recent years, this model has been modified in several respects. In this regard, which of the following statements is incorrect?
(1) Proteins in cell membranes can travel within the lipid bilayer.
(2) Proteins can also undergo flip-flop movements in the lipid bilayer.
(3) Proteins can remain confined within certain domains of the membrane.
(4) Many proteins remain completely embedded within the lipid bilayer.

2005

108. Centromere is required for
(1) movement of chromosomes towards poles
(2) cytoplasmic cleavage
(3) crossing over
(4) transcription.

2005

109. The main organelle involved in modification and routing of newly synthesized proteins to their destinations is
(1) chloroplast
(2) mitochondria
(3) lysosome
(4) endoplasmic reticulum.

2004

110. The telomeres of eukaryotic chromosomes consist of short sequences of
(1) thymine rich repeats
(2) cytosine rich repeats
(3) adenine rich repeats
(4) guanine rich repeats.

2004

111. In chloroplasts, chlorophyll is present in the
(1) outer membrane
(2) inner membrane
(3) thylakoids
(4) stroma.

2003

112. Chromosomes in a bacterial cell can be 1 - 3 in number and
(1) are always circular
(2) are always linear
(3) can be either circular or linear, but never both within the same cell
(4) can be circular as well as linear within the same cell.

2002

113. Ribosomes are produced in
(1) nucleolus
(2) cytoplasm
(3) mitochondria
(4) Golgi body.

2002

114. In fluid mosaic model of plasma membrane,
(1) upper layer is non-polar and hydrophilic
(2) upper layer is polar and hydrophobic
(3) phospholipids form a bimolecular layer in middle part
(4) proteins form a middle layer.

2001

115. Element necessary for the middle lamella is
(1) Ca (2) Zn
(3) K (4) Cu.

2001

116. Microtubules are absent in
(1) mitochondria
(2) flagella
(3) spindle fibres
(4) centrioles.

2000

117. Lysosome contains
(1) oxidative enzymes
(2) hydrolytic enzymes
(3) reductive enzymes
(4) anabolic enzymes.

2000

118. Which of the following ribosomes are engaged in protein synthesis in animal cell?
(1) Ribosomes which occur on nuclear membrane and ER
(2) Ribosomes of only cytosol

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(3) Ribosomes of only nucleolus and cytosol
(4) Ribosomes of only mitochondria and cytosol

2000

119. Function of telomeres in nucleus is
(1) poleward movement
(2) to initiate the RNA synthesis
(3) to seal the ends of chromosome
(4) to recognise the homologous chromosome.

2000

120. Which cell organelle is concerned with glycosylation of protein?
(1) Ribosome
(2) Peroxisome
(3) Endoplasmic reticulum
(4) Mitochondria

1999

121. Photosynthetic bacteria have pigments in
(1) chromoplasts
(2) chromatophores
(3) leucoplasts
(4) chloroplasts.

1999

122. Which of the following organelles has single membrane?
(1) Mitochondria
(2) Spherosomes
(3) Nucleus
(4) Cell wall

1999

123. The proteins are synthesised at
(1) centrosomes
(2) Golgi bodies
(3) ribosomes
(4) mitochondria.

1997

124. The site of respiration in bacteria is
(1) ribosome
(2) microsome
(3) episome
(4) mesosome.

1996

125. Lysosomes are rich in
(1) nucleic acids
(2) hydrolytic enzymes
(3) carbohydrates
(4) hormones.

1995

126. The desmosomes are concerned with
(1) cell division
(2) cell adherence
(3) cytolysis
(4) cellular excretion.

1994

127. Which of the following organelles contain enzymes that have digestive action?
(1) Ribosomes
(2) Polysomes
(3) Plastids
(4) Lysosomes

1994

128. In mitochondria, cristae act as sites for
(1) protein synthesis
(2) phosphorylation of flavoproteins
(3) breakdown of macromolecules
(4) oxidation-reduction reaction.

1994

129. Centromere is required for
(1) replication of DNA
(2) chromosome segregation
(3) pole ward movement of chromosomes
(4) cytoplasmic cleavage.

1994

130. Which one of the following organelles is located near the nucleus and contains a collection of flattened membrane bound cisternae?
(1) Nucleolus
(2) Mitochondrion
(3) Centriole
(4) Golgi apparatus

1994

131. The inner membrane of the mitochondria is usually, highly convoluted forming a series of infoldings known as
(1) thylakoids
(2) lamellae
(3) cristae
(4) grana.

NODIA

1994

132. Besides giving out secretory vesicles, the Golgi apparatus is also concerned with the formation of
(1) lysosomes
(2) plastids
(3) grana of chloroplasts
(4) cell plates after cell division in plants.

1993

133. Which is correct about cell theory in view of current status of our knowledge about cell structure?
(1) It needs modification due to discovery of subcellular structures like chloroplasts and mitochondria.
(2) Modified cell theory means that all living being are composed of cells capable of reproducing.
(3) Cell theory does not hold good because all living beings (e.g., viruses) do not have cellular organisation.
(4) Cell theory means that all living objects consists of cells whether or not capable of reproducing.

1993

134. Names of Schleiden and Schwann are associated with
(1) protoplasm as the physical basis of life
(2) cell theory
(3) theory of cell lineage
(4) nucleus functions as control centre of cell.

1993

135. Active and passive transports across cell membrane differ in
(1) passive transport is nonselective
(2) passive transport is along the concentration gradient while active transport is due to metabolic energy
(3) active transport is more rapid
(4) passive transport is confined to anions while active transport is confined to cations.

1993

136. Balbiani rings (puffs) are sites of
(1) DNA replication
(2) RNA and protein synthesis
(3) synthesis of polysaccharides
(4) synthesis of lipids.

1993

137. In plant cells, peroxisomes are associated with
(1) photorespiration
(2) phototropism
(3) photoperiodism
(4) photosynthesis.

1993

138. Membranous bag with hydrolytic enzymes which is used for controlling intracellular digestion of macromolecules is
(1) endoplasmic reticulum
(2) nucleosome
(3) lysosome
(4) phagosome.

1993

139. Golgi apparatus is absent in
(1) higher plants
(2) yeast
(3) bacteria and blue-green algae
(4) none.

1993

140. Cell recognition and adhesion occur due to biochemicals of cell membranes named
(1) proteins
(2) lipids
(3) proteins and lipids
(4) glycoproteins and glycolipids.

1993

141. In salivary gland chromosomes/polytene chromosomes, pairing is
(1) absent
(2) occasional
(3) formed between non-homologous chromosomes
(4) formed between homologous chromosomes.

1992, 1990

142. Electron microscope has a high resolution power. This is due to
(1) electromagnetic lenses
(2) very low wavelength of electron beam
(3) low wavelength of light source used
(4) high numerical aperture of glass lenses used.

1992

143. Angstrom (Å) is equal to
(1) 0.01 μm
(2) 0.001 μm
(3) 0.0001 μm
(4) 0.00001 μm.

1992

144. All types of plastids possess essentially the same structure because they
(1) perform the same function
(2) store food materials like starch, fat and protein
(3) occur in aerial parts
(4) can transform from one form to another.

1992

145. Experiments on Acetabularia by Hammerling proved the role of
(1) cytoplasm in controlling differentiation
(2) nucleus in heredity

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ANSWERS

1. (4) chromoplast
Chromoplasts are coloured plastids that store pigments such as carotene and xanthophyll, giving yellow, orange and red colours to flowers and fruits. Chloroplasts contain chlorophyll; aleuroplasts and amyloplasts are leucoplasts storing proteins and starch.

2. (3) matrix
The inner mitochondrial membrane is folded into cristae and encloses the mitochondrial matrix. The matrix contains enzymes of the Krebs' cycle, mitochondrial DNA, ribosomes and other components needed for cellular respiration.

3. (2) (a), (b) and (c) only
Prokaryotic 70S ribosomes consist of 50S and 30S subunits (a), they often carry plasmids (b), and possess mesosomes formed by infolding of the plasma membrane (c). Peroxisomes are membrane-bound organelles found only in eukaryotes (d wrong).

4. (4) is the major site for the synthesis of lipids
Smooth ER lacks ribosomes on its surface and is the major site for synthesis of lipids and steroids. Protein synthesis occurs on rough ER, which bears ribosomes. Hence the smooth ER's main function is lipid synthesis.

5. (3) Schleiden and Schwann
Cell theory was formulated by botanist Matthias Schleiden and zoologist Theodore Schwann. They proposed that all plants and animals are composed of cells, and the cell is the basic unit of life. It was later expanded by Rudolf Virchow.

6. (4) A-II, B-IV, C-I, D-III
Cristae are infoldings of the inner mitochondrial membrane (II). Cisternae are disc-shaped sacs of the Golgi apparatus (IV). Thylakoids are flat membrane sacs in the chloroplast stroma (I). Phospholipids form the cell membrane (III).

7. (3) endoplasmic reticulum, Golgi complex, lysosomes and vacuole
The endomembrane system includes the endoplasmic reticulum, Golgi complex, lysosomes and vacuoles, whose functions are coordinated. Mitochondria, chloroplasts and peroxisomes are excluded because they function relatively independently.

8. (3) Nucleolus
The nucleolus is a non-membrane-bound structure within the nucleus and is the site of active ribosomal RNA (rRNA) synthesis and ribosome subunit assembly. The centrosome organises spindle fibres, chromatin carries genetic material, and the kinetochore is the spindle attachment site on the centromere.

9. (1) Ribosomes
Ribosomes are non-membrane bound organelles that occur in both prokaryotic (70S) and eukaryotic (80S) cells, serving as sites of protein synthesis. Lysosomes, centrosomes and mitochondria are absent in prokaryotes; lysosomes and mitochondria are membrane-bound and confined to eukaryotic cells only.

10. (4) B, C and D only
Rough ER bears ribosomes (B correct), mitochondria and plastids both contain circular DNA (C correct), and the cytoskeleton is a network of microtubules, microfilaments and intermediate filaments (D correct). Mitochondria are excluded from the endomembrane system (A wrong) and are double membrane-bound, not single (E wrong).

11. (3) A, B and D only
The human RBC membrane contains about 52% protein (A correct). Phospholipids are arranged in a bilayer (B correct), with hydrophobic tails pointing inward, away from water (D correct). Mesosomes are found in prokaryotes, not eukaryotes (C wrong), and glycocalyx as defined here is not standard for plasma membrane (E wrong).

12. (3) mesosome
Mesosomes are specialized membranous structures found in prokaryotic cells, formed by the extensions of the plasma membrane into the cell. They appear as vesicles, tubules, or lamellae. These structures significantly increase the surface area of the plasma membrane, facilitating essential processes such as cell wall

NODIA

1989

161. Polyribosomes are aggregates of
(1) ribosomes and rRNA
(2) only rRNA
(3) peroxisomes
(4) several ribosomes held together by string of mRNA.

1989

162. Plasma membrane is made of
(1) proteins and carbohydrates
(2) proteins and lipids
(3) proteins, lipids and carbohydrates
(4) proteins, some nucleic acid and lipids.

1988

163. Acetabularia used in Hammerling's nucleocytoplasmic experiments is
(1) unicellular fungus
(2) multicellular fungus
(3) unicellular uninucleate green algae
(4) unicellular multinucleate green algae.

1988

164. According to fluid mosaic model, plasma membrane is composed of
(1) phospholipids and oligosaccharides
(2) phospholipids and hemicellulose
(3) phospholipids and integral proteins
(4) phospholipids, extrinsic proteins and intrinsic proteins.

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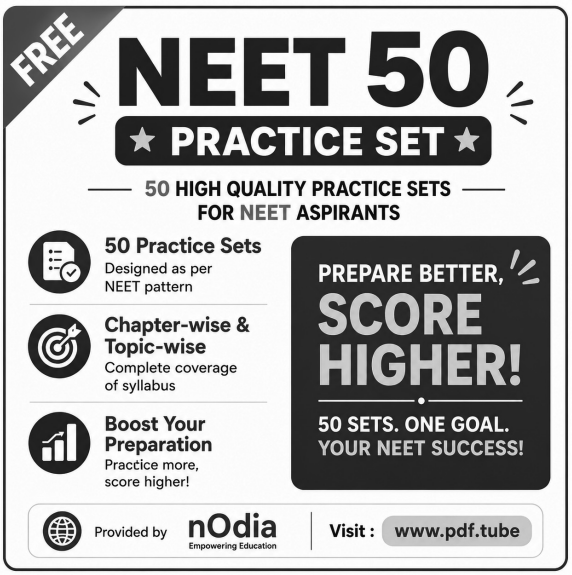

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molecules, the enzymes involved in the electron transport chain and ATP synthesis are specifically embedded in the inner mitochondrial membrane, not the outer membrane as suggested.

41. (3) p-arm and q-arm respectively
In a submetacentric chromosome, the centromere is located slightly away from the center, resulting in one arm being shorter than the other. Biologists refer to the shorter arm as the p-arm, derived from the French word "petit". The longer arm is designated as the q-arm. This nomenclature is standardized for describing chromosomal regions and mapping specific gene locations.

42. (4) Lysosomes and Vacuoles
Most organelles involved in energy transformation or genetic control contain DNA. Mitochondria and chloroplasts possess their own circular DNA, while the nucleus houses the majority of cellular DNA. However, lysosomes, which are involved in digestion, and vacuoles, which store materials, are membrane-bound sacs that do not contain any genetic material of their own, relying on nuclear instructions.

43. (1) A-(iii), B-(iv), C-(ii), D-(i)
Each cellular organelle performs specialized biochemical tasks. The Golgi apparatus is responsible for synthesizing glycoproteins and glycolipids. Lysosomes contain hydrolytic enzymes used for digesting various biomolecules. Vacuoles serve as storage compartments that trap waste and excretory products. Ribosomes are the universal sites for protein synthesis, where amino acids are assembled into polypeptide chains based on genetic instructions.

44. (4) It is a site for active ribosomal RNA synthesis.
The nucleolus is a non-membrane-bound structure located within the nucleus, consisting of proteins and RNA. It is the primary site for the active synthesis of ribosomal RNA and the assembly of ribosomal subunits. Because of its intense metabolic activity related to protein production, larger and more numerous nucleoli are typically found in cells that are actively engaged in protein synthesis.

45. (2) formation of secretory vesicles
The Golgi complex is a central organelle in the eukaryotic secretory pathway. Its primary function is the processing, sorting, and packaging of proteins and lipids received from the endoplasmic reticulum. It organizes these materials into secretory vesicles, which then transport their contents to the plasma membrane for secretion or to other intracellular locations like lysosomes for specialized cellular functions.

46. (4) Phospholipid synthesis
The rough endoplasmic reticulum is primarily involved in the synthesis and processing of proteins destined for secretion or membrane insertion. It facilitates protein folding, glycosylation, and the cleavage of single peptides. In contrast, the synthesis of lipids, including phospholipids and sterols, is a function specifically associated with the smooth endoplasmic reticulum, which lacks attached ribosomes on its membrane surface.

47. (4) Polytene chromosomes - Oocytes of amphibians
Polytene chromosomes are giant chromosomes found in the salivary glands of certain insects, such as Drosophila, formed by repeated rounds of DNA replication without cell division. Lampbrush chromosomes are another type of giant chromosome, specifically observed in the oocytes of amphibians during the diplotene stage of meiosis. Allosomes are sex chromosomes, and sub-metacentric chromosomes typically appear L-shaped during cell division.

48. (3) Mitochondrion
Mitochondria are often called the powerhouses of the cell because they are the site of aerobic respiration. They contain the machinery necessary for the Krebs cycle and the electron transport chain. Through these processes, they extract energy from carbohydrates and other nutrients, converting it into adenosine triphosphate, which serves as the primary energy currency for various cellular activities.

49. (2) Pili and fimbriae are mainly involved in motility of bacterial cells.
Bacterial cell walls are composed of peptidoglycan, and Mycoplasma are unique microorganisms that lack a cell wall. While flagella are the primary structures used for bacterial motility, pili and fimbriae serve different functions. Pili are involved in conjugation, and fimbriae help bacteria attach to surfaces or host tissues. Cyanobacteria are also known to lack flagellated stages in their life.

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formation, DNA replication, distribution to daughter cells, and cellular respiration.

13. (3) Both A and R are true and R is the correct explanation of A.
The Golgi apparatus is primarily responsible for packaging materials synthesized by the endoplasmic reticulum for delivery. Vesicles from the endoplasmic reticulum fuse with the cis face or forming face of the Golgi apparatus. After modification within the cisternae, these materials are released from the trans face or maturing face to their various intracellular or extracellular targets.

14. (3) A, B, C are true.
Ribosomes are essential granular structures composed of ribonucleic acid and proteins. In eukaryotes, the ribosomes are of the 80S type, consisting of 60S and 40S subunits. In prokaryotes, they are 70S, composed of 50S and 30S subunits. Each ribosome requires two subunits to function during protein synthesis, ensuring the translation of genetic information into proteins.

15. (2) A-II, B-III, C-I, D-IV
Specific cellular components perform distinct biological roles essential for life. The centromere is vital for proper chromosome segregation during cell division. Cilia are hair-like appendages facilitating cellular movement or fluid displacement. Cristae are mitochondrial infoldings that increase surface area for aerobic respiration. The cell membrane consists of a phospholipid bilayer providing a selective barrier for the cell.

16. (3) special structure formed by extension of plasma membrane
The mesosome is a characteristic feature of prokaryotic cells, representing an internal folding of the plasma membrane. It is not a membrane-bound organelle but an extension that increases the metabolic surface area. These structures play critical roles in bacterial physiology, including respiration, secretion processes, and providing a site for DNA attachment during the process of binary fission.

17. (1) A-II, B-IV, C-III, D-I
Cell biology history is defined by key discoveries of organelles and structures. Flemming identified chromatin within the nucleus, while Robert Brown first described the nucleus itself. George Palade discovered ribosomes using electron microscopy, noting their role in protein synthesis. Camillo Golgi identified the Golgi apparatus, characterized by disc-shaped sacs or cisternae involved in the packaging of proteins.

18. (4) A-II, B-III, C-IV, D-I
Chromosomes are classified based on the position of the centromere. Metacentric chromosomes have a median centromere forming equal arms. Sub-metacentric types have a centromere slightly away from the middle, creating unequal arms. Acrocentric chromosomes possess a centromere near one end, while telocentric chromosomes have a terminal centromere. These configurations are essential for proper movement during cell division.

19. (2) A-IV, B-I, C-II, D-III
Various cellular components are specifically associated with different organelles or structures. F1 particles are the functional units of ATP synthesis found in mitochondria. Histones are basic proteins that organize DNA into chromosomes. The axoneme forms the core structure of cilia and flagella. Cisternae are the flattened, membrane-bound sacs that constitute the functional units of the Golgi apparatus.

20. (4) Both statement I and statement II are false.
In the Golgi complex, the cis face is the forming face and is convex, while the trans face is the maturing face and is concave. Statement I incorrectly swaps these descriptions. Statement II is false because proteins modified within the cisternae are released from the trans face, not the cis face, after they are packaged into secretory vesicles.

21. (4) A-II, B-I, C-IV, D-III
Different cellular structures have specific architectural patterns and locations. The axoneme is the core of cilia and flagella, exhibiting a 9+2 microtubule arrangement. Centrioles show a cartwheel pattern in their cross-section. Cristae are infoldings of the inner mitochondrial membrane that host respiratory enzymes. A satellite is a chromosomal region located beyond a secondary constriction in certain chromosomes.

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form the Golgi apparatus. Chromatin represents the organized, condensed structure of DNA and proteins found within the nucleus.

60. (2) lysosomes, Golgi apparatus and mitochondria
Many cellular organelles are defined by the presence of a surrounding membrane. Lysosomes and the Golgi apparatus are single-membrane bound, while mitochondria are double-membrane bound. In contrast, ribosomes, centrosomes, and nucleoli are examples of cellular structures that lack a limiting membrane. Chromosomes are composed of DNA and proteins but are not considered membrane-bound organelles in the same structural sense.

61. (4) Ribosomes
Ribosomes are unique cellular structures because they are not enclosed by a membrane. They are composed of ribosomal RNA and proteins, functioning as the site for protein synthesis in both prokaryotic and eukaryotic cells. Other structures like lysosomes, vacuoles, and mesosomes are all associated with membranes. The lack of a membrane allows ribosomes to exist freely in the cytoplasm or attach to membranes.

62. (4) ribosomes.
DNA is the genetic material found in specific locations within a cell. The nucleus contains the majority of cellular DNA, while mitochondria and chloroplasts possess their own extra-nuclear circular DNA. Ribosomes, however, are composed strictly of ribosomal RNA and various proteins. They are the site where the genetic code is translated into proteins, but they do not contain any DNA themselves.

63. (2) rough endoplasmic reticulum
The nuclear envelope is a double-membrane structure that encloses the nucleus. During cell division, it breaks down and later reforms. It is structurally and functionally linked to the endomembrane system. Specifically, the outer membrane of the nuclear envelope is continuous with the rough endoplasmic reticulum and often has ribosomes attached to its surface, indicating its origin from this membrane system.

64. (4) grana.
Within the chloroplast, the stroma contains an organized system of flattened membranous sacs called thylakoids. These thylakoids are arranged in stacks, similar to a pile of coins, and each stack is known as a granum. Grana are the sites where the light-dependent reactions of photosynthesis occur, housing the chlorophyll pigments and proteins necessary for capturing solar energy and producing ATP.

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65. (4) Smooth ER - Synthesis of lipids
The endoplasmic reticulum is divided into two types based on the presence of ribosomes. Rough ER is primarily responsible for protein synthesis and modification. Smooth ER lacks ribosomes and is the major site for the synthesis of lipids, including phospholipids and cholesterol. In animal cells, smooth ER is also involved in the synthesis of steroid hormones and the detoxification of drugs.

66. (4) acrocentric.
Chromosomes are categorized by centromere position. In an acrocentric chromosome, the centromere is located very close to one end. This results in the formation of one arm that is extremely short and another arm that is significantly longer. This configuration is distinct from telocentric chromosomes, where the centromere is truly terminal, and metacentric chromosomes, where the centromere is positioned in the middle.

67. (4) Mesosomes
Bacteria are prokaryotes and lack membrane-bound organelles like mitochondria. Instead, they utilize specialized structures called mesosomes, which are internal folds of the plasma membrane. Mesosomes contain the enzymes necessary for cellular respiration and ATP production, functionally mimicking the role that mitochondria play in eukaryotic cells. They also participate in other vital processes such as DNA replication and cell wall synthesis.

68. (2) flagella
Motility in bacteria is primarily achieved through the use of flagella. These are long, thin, whip-like appendages that extend from the cell surface and rotate to propel the bacterium through liquid environments. Bacterial flagella are composed of the protein flagellin and differ in structure and mechanism from eukaryotic flagella. Other appendages like fimbriae and pili are used for attachment and conjugation.

lacks them and synthesizes lipids. Prokaryotic cells, however, do not possess membrane-bound organelles like the endoplasmic reticulum. Therefore, the statement claiming that prokaryotes contain rough endoplasmic reticulum is biologically incorrect.

32. (2) Mature sieve tube elements possess a conspicuous nucleus and usual cytoplasmic organelles.
Mature sieve tube elements are specialized cells in the phloem of plants that lose their nucleus and many organelles to facilitate the efficient transport of nutrients. They maintain a peripheral layer of cytoplasm but depend on companion cells for nuclear functions. Other statements correctly describe nuclear pores, the presence of microbodies, and the function of the perinuclear space.

33. (4) (iii) (iv) (i) (ii)
Specific structural components define different cellular organelles. Cristae are the internal folds of the mitochondria that increase surface area for respiration. Thylakoids are flattened sacs found within the stroma of plastids like chloroplasts. The centromere is the primary constriction point on a chromosome. Cisternae are the characteristic disc-shaped, membrane-bound sacs that make up the stack of the Golgi apparatus.

34. (2) metacentric
A metacentric chromosome is characterized by having its centromere located exactly in the middle. This central positioning results in the formation of two arms of approximately equal length. During anaphase of cell division, these chromosomes typically appear V-shaped as they are pulled toward the opposite poles, ensuring equal distribution of genetic material to the daughter cells produced.

35. (3) Endoplasmic reticulum, Golgi complex, lysosomes and vacuoles
The endomembrane system is a group of eukaryotic membranes and organelles that function together to modify, package, and transport lipids and proteins. This interconnected system includes the nuclear envelope, endoplasmic reticulum, Golgi complex, lysosomes, and vacuoles. Mitochondria and chloroplasts are excluded from this system because they function semi-autonomously and are not physically or functionally integrated with these specific membranes.

36. (2) These are involved in ingestion of food particles.
Inclusion bodies are non-membranous structures found in the cytoplasm of prokaryotic cells, serving as storage sites for reserve materials. Examples include phosphate granules, cyanophycean granules, and glycogen granules. They lie free in the cytoplasm and are not involved in active processes like the ingestion of food particles. Ingestion typically involves membrane-bound vesicles, which prokaryotes generally lack.

37. (3) Golgi bodies
Golgi bodies, or the Golgi apparatus, play a crucial role in the post-translational modification of proteins and lipids. This organelle is the primary site where carbohydrates are added to proteins and lipids to form glycoproteins and glycolipids, respectively. These molecules are then sorted and packaged into vesicles for transport to their final destinations, either inside or outside the cell.

NODIA

38. (2) Rudolf Virchow
Rudolf Virchow made a landmark contribution to cell theory in 1855 by proposing the principle "Omnis cellula-e-cellula". This phrase translates to "all cells arise from pre-existing cells", explaining the basis of cell division. His work expanded upon the earlier theories of Schleiden and Schwann, providing a complete understanding of how living organisms grow, develop, and reproduce at the cellular level.

39. (1) Lysosomes are formed by the process of packaging in the endoplasmic reticulum.
Lysosomes are membrane-bound vesicular structures formed by the process of packaging specifically in the Golgi apparatus, not the endoplasmic reticulum. They contain various hydrolytic enzymes such as lipases and proteases, which are optimally active under acidic pH conditions. These enzymes are responsible for digesting macromolecules, old organelles, and foreign substances within the cell to maintain cellular health.

40. (3) Enzymes of electron transport are embedded in outer membrane.
Mitochondria are double-membrane organelles where the inner membrane is folded into cristae to increase surface area. The matrix contains circular DNA and ribosomes. While the outer membrane is permeable to various small

22. (3) Statement I is correct but Statement II incorrect.
Mitochondria and chloroplasts are both double-membrane bound organelles essential for energy transformation. The first statement accurately reflects this structural similarity. However, the second statement is incorrect because the inner membranes of both organelles are highly selective, and the inner membrane of both organelles is significantly less permeable and more selective than the outer membrane.

23. (1) A-III, B-II, C-IV, D-I
Specific organelles are specialized for distinct cellular metabolic functions. The nucleolus is the primary site for ribosomal RNA synthesis. Centrioles exhibit a cartwheel-like organization of microtubules. Leucoplasts are colorless plastids primarily used for storing nutrients like starch, oils, or proteins. The Golgi apparatus is the major site for the synthesis and modification of glycoproteins and glycolipids.

24. (2) circular, double stranded
Chloroplasts are semi-autonomous organelles that contain their own genetic material, independent of the nucleus. This DNA is typically double-stranded and arranged in a circular molecule, similar to the DNA found in prokaryotic cells. This characteristic supports the endosymbiotic theory, which suggests that chloroplasts evolved from ancient free-living cyanobacteria that were engulfed by a primitive eukaryotic host.

25. (3) Both statement I and statement II are correct.
Mesosomes are characteristic extensions of the plasma membrane in bacteria, taking the form of vesicles, tubules, or lamellae. They perform multiple functions vital for bacterial survival. They help in increasing the surface area for respiration and secretion. Furthermore, mesosomes are involved in the synthesis of the cell wall and the replication and distribution of DNA during division.

26. (2) (A) and (C) only
The Golgi apparatus serves as a central hub for the modification and trafficking of proteins and lipids. It is the principal site for the formation of glycoproteins and glycolipids through glycosylation. Additionally, it modifies proteins that have been synthesized on the ribosomes of the rough endoplasmic reticulum, preparing them for secretion or delivery to specific intracellular locations.

27. (1) Motility
The cytoskeleton is an elaborate network of proteinaceous filaments, including microtubules, microfilaments, and intermediate filaments, present in the cytoplasm. It provides mechanical support to the cell and helps maintain its shape. One of its primary functions is enabling motility, both of the entire cell and the movement of various organelles and vesicles within the cellular environment.

28. (4) A, C and E only
The endomembrane system consists of organelles whose functions are coordinated, including the endoplasmic reticulum, Golgi complex, lysosomes, and vacuoles. Mitochondria, chloroplasts, and peroxisomes are not considered part of this system because their functions are not integrated with the others. Mitochondria and chloroplasts are semi-autonomous, while peroxisomes are involved in specialized oxidative reactions and metabolic processes.

29. (3) 80
Ribosomes are complex molecular machines responsible for protein synthesis in all living cells. They are composed of ribosomal RNA molecules and a large number of specific proteins. In eukaryotic cells, a single ribosome consists of approximately eighty different types of proteins, which work together with the rRNA to facilitate the translation of messenger RNA into polypeptide chains.

30. (1) (A)-(iii), (B)-(i), (C)-(iv), (D)-(ii)
Chromosome classification depends on centromere placement. Metacentric chromosomes have a middle centromere and equal arms. Acrocentric chromosomes have a centromere near the end, producing one very short arm. Sub-metacentric chromosomes have a centromere slightly off-center, resulting in unequal arms. Telocentric chromosomes possess a centromere at the terminal end. These distinct structures are clearly visible during the metaphase of mitosis.

31. (3) In prokaryotes only RER are present
The endoplasmic reticulum is a network of membranous tubules found in eukaryotic cells, categorized into rough and smooth types. Rough ER has attached ribosomes, while smooth ER

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50. (2) Large central vacuoles - Animal cells
Plant cells are characterized by the presence of a large central vacuole that maintains turgor pressure and stores nutrients or waste. In contrast, animal cells typically have much smaller, temporary vacuoles, if any are present at all. Gas vacuoles are found in certain photosynthetic bacteria, protists are eukaryotic organisms, and methanogens are a specialized group of prokaryotic archaebacteria.

51. (1) lysosome
Lysosomes are membrane-bound organelles that function as the cell's digestive system. They contain a variety of hydrolytic enzymes, such as proteases, nucleases, and lipases, which can break down all types of biological polymers. These enzymes are active at an acidic pH, which is maintained inside the lysosome, allowing for the efficient degradation of waste materials and foreign substances.

52. (1) (A) is true but (B) is false.
Mitochondria and chloroplasts are semi-autonomous organelles because they contain their own DNA and can replicate independently. While they contain their own ribosomes and protein-synthesizing machinery, they are not completely independent and rely on nuclear DNA for some proteins. Therefore, the statement that they lack protein-synthesizing machinery is false, as they possess their own ribosomes to produce proteins.

53. (4) spindle fibres, centrioles and cilia.
Microtubules are hollow, cylindrical structures composed of tubulin protein subunits. They form the essential structural framework for several cellular components. These include the spindle fibres used during cell division to separate chromosomes, the centrioles which organize these fibres, and the core of cilia and flagella, providing the necessary support and mechanism for cellular movement and transport.

54. (1) Lysosomes
Cellular organelles are classified by the number of membranes surrounding them. Nuclei, mitochondria, and chloroplasts are double-membrane organelles, reflecting their complex roles and evolutionary origins. In contrast, lysosomes are simple, spherical sacs enclosed by only a single unit membrane. This single membrane is sufficient to contain the hydrolytic enzymes required for intracellular digestion and protects the rest of the cell.

55. (2) anthocyanins
Anthocyanins are a group of water-soluble pigments belonging to the flavonoid family. Unlike chlorophylls, carotenoids, and xanthophylls, which are fat-soluble and found within the membranes of plastids, anthocyanins are typically stored in the cell sap of vacuoles. They are responsible for the red, purple, and blue colors observed in many flowers, fruits, and some types of plant leaves.

56. (3) Nuclear envelope
Prokaryotic cells are distinguished by their lack of a membrane-bound nucleus and other complex organelles. While they possess a plasma membrane, ribosomes for protein synthesis, and specialized membrane structures like mesosomes, they do not have a nuclear envelope to enclose their genetic material. Instead, the DNA of a prokaryote is located in an irregularly shaped region called the nucleoid.

57. (4) fimbriae.
Fimbriae are short, hair-like proteinaceous appendages found on the surface of many bacteria. They are much thinner and more numerous than flagella. Their primary biological function is to enable bacteria to adhere to solid surfaces, such as rocks in streams, or to the tissues of a host organism. This attachment is a critical step in colonization and the establishment of infections.

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58. (2) Polysome
Inclusion bodies in prokaryotes are non-membranous structures used to store reserve materials like phosphate, glycogen, or cyanophycean granules. A polysome, or polyribosome, is not a storage body but a functional unit consisting of a string of multiple ribosomes attached to a single messenger RNA molecule. Polysomes allow for the simultaneous translation of the same genetic message into multiple protein copies.

59. (4) A-(iii), B-(iv), C-(i), D-(ii)
Cellular structures are identified by their specific morphology and location. Thylakoids are the flattened membranous sacs found in the stroma of chloroplasts. Cristae refer to the internal folds of the inner mitochondrial membrane. Cisternae are the disc-shaped sacs that stack together to

(3) chromosomes in heredity
(4) nucleo-cytoplasmic ratio.

1992

146. Which one is apparato reticolare?
(1) Golgi apparatus
(2) Endoplasmic reticulum
(3) Microfilaments
(4) Microtubules

1992

147. An outer covering membrane is absent over
(1) nucleolus
(2) lysosome
(3) mitochondrion
(4) plastid.

1992

148. All plastids have similar structure because they can
(1) store starch, lipids and proteins
(2) get transformed from one type to another
(3) perform same function
(4) be present together.

1992

149. Oxysomes or F_0 - F_1 particles occur on
(1) thylakoids
(2) mitochondrial surface
(3) inner mitochondrial membrane
(4) chloroplast surface.

1992

150. Ribosomes are the centre for
(1) respiration
(2) photosynthesis
(3) protein synthesis
(4) fat synthesis.

1992

151. Which is distributed more widely in a cell?
(1) DNA
(2) RNA
(3) Chloroplasts
(4) Sphaerosomes

1991

152. Addition of new cell wall particles amongst the existing ones is
(1) deposition
(2) apposition
(3) intussusception
(4) aggregation.

1991

153. Cell wall shows
(1) complete permeability
(2) semipermeability
(3) differential permeability
(4) impermeability.

1991

154. Ribosomes were discovered by
(1) Golgi
(2) Porter
(3) de Robertis
(4) Palade.

1991

155. Fluid mosaic model of cell membrane was put forward by
(1) Danielli and Davson
(2) Singer and Nicolson
(3) Garner and Allard
(4) Watson and Crick.

1990

156. Magnification of compound microscope is not connected with
(1) numerical aperture
(2) focal length of objective
(3) focal length of eye piece
(4) tube length.

1990

157. Hammerling's experiments of Acetabularia involved exchanging
(1) cytoplasm
(2) nucleus
(3) rhizoid and stalk
(4) gametes.

1990

158. The latest model for plasma membrane is
(1) lamellar model
(2) unit membrane model
(3) fluid mosaic model
(4) molecular lipid model.

1989

159. Organelles can be separated from cell homogenate through
(1) chromatography
(2) X-rays diffraction
(3) differential centrifugation
(4) auto-radiography.

1989

160. Nucleoproteins are synthesised in
(1) nucleoplasm
(2) nuclear envelope
(3) nucleolus
(4) cytoplasm.

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69. (2) microfilaments
Microfilaments are solid, linear elements of the cytoskeleton with a diameter of approximately 6 nanometers. They are composed of actin protein monomers that polymerize to form long, flexible chains. These filaments play a crucial role in maintaining cell shape, enabling cellular movement, and facilitating cytokinesis during cell division. They are much thinner than microtubules and provide essential structural support within the cytoplasm.

70. (2) vacuoles
In plant cells, the vacuole is a large, membrane-bound organelle that can occupy up to ninety percent of the cell's volume. It contains cell sap, which is a concentrated solution of salts, sugars, and organic acids. This high concentration of solutes creates osmotic pressure, causing water to enter the cell and the vacuole to expand. This process is vital for maintaining turgor.

71. (1) (iv) (ii) (i) (iii)
Various cellular components are matched with their specific structures or functions. Centrioles form the basal body of cilia and flagella. Chlorophyll is the light-capturing pigment located within the thylakoids of chloroplasts. Cristae are the internal infoldings of the mitochondrial membrane that host respiration enzymes. Ribozymes are specialized RNA molecules that function as biological catalysts, proving that some nucleic acids have enzymatic activity.

72. (3) It allows bacterium to "hide" from host's immune system.
Many bacteria are surrounded by a thick, polysaccharide layer called a capsule. This capsule provides a significant advantage by acting as a protective shield against the host's immune response. It prevents phagocytic white blood cells from recognizing and engulfing the bacterium. By evading the immune system, encapsulated bacteria can survive more effectively within the host, often increasing their virulence and pathogenicity.

73. (4) a layer surrounding the cell wall of bacteria.
The glycocalyx is the outermost layer of the bacterial cell envelope, situated outside the cell wall. It is composed of a coating of macromolecules, typically polysaccharides or proteins. Depending on its consistency and thickness, it may be organized into a well-defined capsule or a loose, unorganized slime layer. It plays important roles in protection, adhesion to surfaces, and evasion of host defenses.

74. (2) in post translational modification of proteins and glycosylation of lipids
The Golgi complex is essential for the maturation of biological molecules. After proteins and lipids are synthesized in the endoplasmic reticulum, they are transported to the Golgi apparatus. Here, they undergo post-translational modifications, such as the addition of carbohydrate chains. This process, known as glycosylation, is vital for the proper functioning, stability, and targeting of glycoproteins and glycolipids within the cell.

75. (2) Rough endoplasmic reticulum, protein synthesis
The rough endoplasmic reticulum is characterized by the presence of ribosomes on its outer surface, giving it a granular appearance. These ribosomes are the primary sites where amino acids are assembled into proteins. Therefore, the rough endoplasmic reticulum is specialized for the synthesis of proteins, particularly those that are destined for secretion, incorporation into the cell membrane, or delivery to lysosomes.

76. (4) SER
The smooth endoplasmic reticulum is a network of membranous tubules that lacks attached ribosomes. This structural difference from the rough endoplasmic reticulum reflects its distinct metabolic functions. It is the major site for the synthesis of various lipids, including phospholipids, cholesterol, and steroid hormones. Additionally, the smooth ER is involved in the detoxification of metabolic byproducts and harmful chemicals.

77. (1) Chromoplasts
Plastids are classified based on the types of pigments and materials they contain. Amyloplasts, elaioplasts, and aleuroplasts are types of leucoplasts that store starch, oils, and proteins, respectively. In contrast, chromoplasts are pigmented plastids that contain fat-soluble carotenoid pigments like carotene and xanthophylls. They give flowers and fruits their distinct yellow, orange, or red colors but do not store food materials.

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114. (3) phospholipids form a bimolecular layer in middle part
In the fluid mosaic model, the plasma membrane is primarily composed of a phospholipid bilayer. This bilayer forms the structural core of the membrane, with the hydrophobic tails of the phospholipids facing inward and the hydrophilic heads facing the watery environments inside and outside the cell. Proteins are embedded within or associated with this bimolecular lipid layer, contributing to its mosaic-like appearance.

115. (1) Ca
Calcium is an essential element for plant structure and growth. It is a major component of the middle lamella, which is the layer that cements adjacent plant cells together. Specifically, calcium ions combine with pectic acid to form calcium pectate, a glue-like substance that provides stability and structural integrity to the plant tissues by holding the individual cell walls in place.

116. (1) mitochondria
Microtubules are structural protein filaments that make up the cytoskeleton and form the basis of several complex cellular structures. They are essential components of centrioles, spindle fibers used in cell division, and the internal structure of cilia and flagella. Mitochondria, however, are membrane-bound organelles with their own internal matrix and cristae; they do not contain microtubules as part of their standard anatomy.

117. (2) hydrolytic enzymes
Lysosomes are small, spherical, membrane-bound sacs filled with a potent mixture of hydrolytic enzymes. These enzymes, including proteases, lipases, and nucleases, are capable of breaking down various biological macromolecules such as proteins, fats, and nucleic acids. This digestive capacity allows lysosomes to recycle old cellular components and destroy foreign materials, playing a vital role in maintaining the health and cleanliness of the cell.

118. (1) Ribosomes which occur on nuclear membrane and ER
In animal cells, protein synthesis is carried out by ribosomes found in different locations. Some ribosomes are free in the cytosol, while others are attached to the outer surface of the nuclear membrane and the rough endoplasmic reticulum. These membrane-associated ribosomes are specifically responsible for synthesizing proteins that are destined for secretion, incorporation into cell membranes, or delivery to specialized organelles like lysosomes.

119. (3) to seal the ends of chromosome
Telomeres are specialized DNA-protein structures located at the very tips of linear eukaryotic chromosomes. Their primary function is to act as protective caps that seal the ends of the chromosomes. By doing so, they prevent the ends from being recognized as broken DNA and protect them from degradation by enzymes or fusion with other chromosomes, thereby ensuring the stability of the entire genome.

120. (3) Endoplasmic reticulum
Glycosylation is the biochemical process of adding carbohydrate chains to proteins or lipids. This process begins in the lumen of the endoplasmic reticulum, where basic sugar chains are attached to newly synthesized polypeptides. These molecules are then further modified and refined as they move through the Golgi apparatus. Thus, the endoplasmic reticulum is a major site for the initial steps of protein glycosylation.

121. (2) chromatophores.
Photosynthetic bacteria lack complex organelles like chloroplasts found in plants. Instead, they contain specialized internal membrane systems called chromatophores. These structures house the photosynthetic pigments, such as bacteriochlorophyll, and the enzymes necessary for capturing light energy and converting it into chemical energy. The arrangement of these pigments allows the bacteria to perform photosynthesis efficiently within their relatively simple prokaryotic cell structure.

122. (2) Spherosomes
Organelles are often categorized by the number of membranes they possess. Mitochondria and the nucleus are double-membrane organelles, while the cell wall is a rigid extracellular structure, not an organelle. Spherosomes are small, spherical, single-membrane-bound organelles involved in the synthesis and storage of lipids. They are commonly found in plant cells and are part of the microbody family, similar to peroxisomes and glyoxysomes.

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87. (2) B (inner membrane) - forms infoldings called cristae
Mitochondria have a distinct double-membrane structure. The inner membrane is highly specialized and is folded inward many times to form structures called cristae. These infoldings significantly increase the surface area of the inner membrane, which is necessary to accommodate a large number of electron transport chain complexes and ATP synthase enzymes required for efficient energy production during aerobic cellular respiration.

88. (2) proteins embedded in a phospholipid bilayer
The plasma membrane is organized according to the fluid mosaic model. Its structural foundation is a bilayer of phospholipid molecules, which have hydrophilic heads and hydrophobic tails. Various proteins are embedded within or associated with this bilayer. Integral proteins span the membrane, while peripheral proteins are attached to its surface. This arrangement provides structural integrity and facilitates regulated transport across the membrane.

89. (3) cytoplasm
The cytoplasm is the semi-fluid matrix that fills the interior of the cell between the plasma membrane and the nucleus. It is the primary arena for the majority of cellular activities and metabolic reactions. Both prokaryotic and eukaryotic cells contain various organelles and molecules suspended in the cytoplasm, where essential processes such as protein synthesis, glycolysis, and intracellular transport occur continuously.

90. (1) Mitochondria
Mitochondria are semi-autonomous organelles, meaning they have some degree of independence from the cell's nucleus. One key piece of evidence for this is that they contain their own small, circular DNA molecules, similar to bacterial DNA. This mitochondrial DNA encodes several essential proteins and RNA molecules used by the organelle, allowing it to grow and divide independently of the main cell division.

91. (1) Plasmodesmata
In plants, adjacent cells are often connected by specialized channels called plasmodesmata. These are cytoplasmic bridges that pass through the cell walls, directly linking the cytoplasm of neighboring cells. Plasmodesmata facilitate the efficient transport of water, nutrients, and signaling molecules between cells, allowing for coordinated growth and physiological responses throughout the various tissues and organs of the entire plant body.

92. (4) cytoskeleton.
The cytoskeleton is an elaborate and dynamic network of proteinaceous filaments located within the cytoplasm of eukaryotic cells. It consists of microtubules, microfilaments, and intermediate filaments. This network provides a structural framework that maintains the shape of the cell and organizes its contents. Beyond structural support, the cytoskeleton is also essential for cellular movement, intracellular transport, and the process of cell division.

93. (1) (v) (iv) (viii) (iii)
Cellular diagrams often highlight the relationships between different membrane systems and the nucleus. In such diagrams, the rough endoplasmic reticulum is distinguished by attached ribosomes, while the smooth endoplasmic reticulum appears as a network of smooth tubules. The nucleus is usually the most prominent central organelle, and the surrounding cytoplasm serves as the medium containing all other structures and metabolic components.

94. (2) calcium pectate
The middle lamella is the outermost layer of the plant cell wall, acting as a cementing layer between the walls of adjacent plant cells. It is primarily composed of pectic compounds, mainly calcium pectate. This sticky substance holds the cells together, providing structural integrity to plant tissues. During fruit ripening, the middle lamella often breaks down, leading to the softening of the fruit.

95. (3) proteinaceous filaments
The cytoskeleton is a complex network of fibers extending throughout the cytoplasm of eukaryotic cells. It is composed of three main types of proteinaceous filaments: microfilaments made of actin, microtubules made of tubulin, and intermediate filaments made of various fibrous proteins. These filaments work together to provide mechanical strength, facilitate cellular motility, and assist in the organized transport of organelles and vesicles.

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132. (1) lysosomes
The Golgi apparatus is a multifunctional organelle involved in the sorting and packaging of cellular products. In addition to producing secretory vesicles, it is directly involved in the formation of lysosomes. Some vesicles budding from the Golgi contain hydrolytic enzymes and eventually mature into lysosomes. These organelles are essential for intracellular digestion, demonstrating the integrated nature of the cell's endomembrane system.

133. (3) Cell theory does not hold good because all living beings (e.g., viruses) do not have cellular organisation.
The cell theory states that all living things are composed of cells and that cells are the basic unit of life. However, modern knowledge identifies exceptions such as viruses. Viruses lack a cellular organization, consisting only of genetic material and a protein coat. Because they can only reproduce inside a host cell and lack independent metabolism, they challenge the universal application.

134. (2) cell theory
Matthias Schleiden and Theodor Schwann are historically significant for formulating the cell theory in the late 1830s. Schleiden, a botanist, observed that all plants are made of cells, while Schwann, a zoologist, concluded that all animal tissues are also composed of cells. Together, their work established the fundamental biological principle that the cell is the basic structural and functional unit.

135. (2) passive transport is along the concentration gradient while active transport is due to metabolic energy
Active and passive transport are two primary ways molecules cross cell membranes. Passive transport occurs spontaneously along a concentration gradient, moving substances from areas of high to low concentration without requiring energy. In contrast, active transport moves molecules against their concentration gradient, a process that requires the expenditure of metabolic energy, typically in the form of ATP, to power transport proteins.

136. (2) RNA and protein synthesis
Balbiani rings, also known as chromosomal puffs, are large, localized swellings found on polytene chromosomes in certain insect tissues. These puffs are regions of the DNA that have become uncoiled to allow for intense genetic activity. Specifically, they are the sites of active transcription, where large amounts of RNA are synthesized and subsequently translated into proteins required for specialized cellular functions.

137. (1) photorespiration
In plant cells, peroxisomes are small, membrane-bound microbodies that play a vital role in photorespiration. This process occurs in C_3 plants when oxygen competes with carbon dioxide for the enzyme RuBisCO. Peroxisomes work in coordination with chloroplasts and mitochondria to metabolize phosphoglycolate, a byproduct of this reaction. This complex metabolic pathway helps manage carbon loss and protects the plant under certain environmental conditions.

138. (3) lysosome
A lysosome is a membrane-bound bag or vesicle containing a variety of hydrolytic enzymes. Its primary function is to facilitate intracellular digestion by breaking down large macromolecules such as proteins, nucleic acids, and polysaccharides. By maintaining an acidic internal environment, the lysosome ensures these enzymes work efficiently to recycle cellular components or destroy foreign substances that have been taken up by the cell.

139. (3) bacteria and blue-green algae
The Golgi apparatus is a complex, membrane-bound organelle characteristic of eukaryotic cells. Prokaryotic organisms, such as bacteria and blue-green algae, do not possess membrane-bound organelles. Therefore, they lack a Golgi apparatus, as well as mitochondria and an endoplasmic reticulum. In these simpler organisms, the functions typically performed by these organelles occur in the cytoplasm or at the plasma membrane surface.

140. (4) glycoproteins and glycolipids.
Cell membranes are coated with a variety of carbohydrate-containing molecules called glycoproteins and glycolipids. These molecules extend from the cell surface and act as chemical markers or signatures. They are essential for cell recognition, allowing cells of the same type to identify and adhere to each other. They also play a key role in immune responses, enabling the body to distinguish self.

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proteins using energy from ATP hydrolysis to move microtubules.

105. (1) Blue
The resolution of a microscope is inversely proportional to the wavelength of the light used for illumination. To obtain the best possible resolution and see finer details, a shorter wavelength of light is preferred. Among the colors of visible light, blue light has a shorter wavelength compared to green, yellow, or red light. Therefore, illuminating the object with blue light provides better resolution.

106. (1) grana
Chloroplasts contain a complex system of internal membranes where the light-harvesting pigments are located. Chlorophyll, the primary pigment for photosynthesis, is specifically found within the membranes of the thylakoids. These thylakoids are organized into stacks called grana. The grana are the sites of the light-dependent reactions, where solar energy is captured and converted into chemical energy in the form of ATP.

107. (2) Proteins can also undergo flip-flop movements in the lipid bilayer.
The fluid mosaic model characterizes the cell membrane as a fluid structure where lipids and proteins move laterally. Phospholipids can occasionally move from one layer to the other, known as flip-flop movement. However, because of their large size and specific orientation, membrane proteins are restricted to lateral movement and cannot perform flip-flop movements across the hydrophobic core of the lipid bilayer.

108. (1) movement of chromosomes towards poles
The centromere is a critical region of a chromosome where the two sister chromatids are held together. During cell division, the centromere serves as the assembly site for the kinetochore, a protein complex that attaches to spindle fibers. These fibers pull the chromosomes toward the opposite poles of the cell, ensuring that each daughter cell receives an accurate and complete set of genetic material.

109. (4) endoplasmic reticulum.
The endoplasmic reticulum is a major site for the synthesis and initial processing of proteins in eukaryotic cells. After synthesis, proteins undergo folding and various modifications within the ER lumen. The ER is also involved in the routing of these newly synthesized proteins by packaging them into transport vesicles that are destined for the Golgi apparatus or other specific cellular compartments and membranes.

110. (4) guanine rich repeats.
Telomeres are specialized structures found at the ends of linear eukaryotic chromosomes. They consist of highly repetitive DNA sequences that protect the chromosome from degradation and fusion with other chromosomes. In most eukaryotes, these repetitive sequences are characterized by being rich in guanine residues. These guanine-rich repeats form stable structures that are essential for maintaining the overall stability and integrity of the genome.

111. (3) thylakoids
Inside the chloroplast, chlorophyll is not uniformly distributed but is anchored within specialized membrane systems. These are the thylakoids, which are flattened, sac-like structures. The thylakoid membranes contain the photosystems and pigment-protein complexes that capture light energy during photosynthesis. While the stroma contains enzymes for the dark reaction, the thylakoids are the specific location where light absorption and energy conversion happen.

112. (1) are always circular
Bacterial cells typically contain a single, main chromosome that holds the majority of their genetic information. Unlike the linear chromosomes found in eukaryotic nuclei, bacterial chromosomes are organized as closed, circular DNA molecules. This circular structure is efficient for replication and is located in the nucleoid region of the cell. Some bacteria may also contain smaller, independent circular DNA molecules called plasmids.

113. (1) nucleolus
The nucleolus is a dense, non-membrane-bound structure found within the nucleus of eukaryotic cells. It serves as the primary factory for ribosome production. Within the nucleolus, ribosomal RNA is transcribed from DNA and then combined with proteins imported from the cytoplasm to form the large and small ribosomal subunits. These subunits are subsequently exported back to the cytoplasm to begin protein synthesis.

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They provide the structural framework and catalytic activity needed to assemble amino acids into polypeptide chains. By following the genetic instructions carried by messenger RNA, ribosomes ensure that proteins are built with the correct sequence of amino acids, making them the essential centers for all protein synthesis in cells.

151. (2) RNA
In a typical cell, ribonucleic acid is more widely distributed than deoxyribonucleic acid. While DNA is primarily confined to the nucleus and a few organelles like mitochondria and chloroplasts, RNA is found throughout the cell. It exists in the nucleus as mRNA and tRNA, in the cytoplasm, and in large quantities within the ribosomes, reflecting its diverse roles in genetic expression.

152. (3) intussusception
Growth of the plant cell wall can occur through two main mechanisms. Apposition involves the deposition of new layers of material onto the existing wall surface. Intussusception is a different process where new cell wall particles are inserted into the spaces amongst the existing wall components. This internal expansion allows the cell wall to grow and stretch as the cell increases in size.

153. (1) complete permeability
The plant cell wall is a rigid, outer layer composed mainly of cellulose, hemicellulose, and pectin. Unlike the plasma membrane, which is selectively or differentially permeable, the cell wall is typically completely permeable to water and dissolved solutes. Its porous structure allows molecules to pass through freely, while providing the necessary mechanical support and protection to the cell and its internal membrane.

154. (4) Palade.
Ribosomes were first observed and described as dense granules in the cytoplasm by the cell biologist George Palade in 1953 using electron microscopy. For his extensive work on the structure and function of the cell, including the discovery of ribosomes and their role in protein synthesis, he was later awarded the Nobel Prize in Physiology or Medicine in 1974.

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155. (2) Singer and Nicolson.
The fluid mosaic model of the cell membrane was proposed by S.J. Singer and Garth L. Nicolson in 1972. This groundbreaking model describes the plasma membrane as a fluid phospholipid bilayer with various proteins embedded or floating within it. It provided a comprehensive framework for understanding membrane dynamics, transport, and signaling, and remains the most widely accepted scientific model of membrane structure.

156. (1) numerical aperture
The total magnification of a compound microscope is determined by the magnifying power of the objective lens and the eyepiece, which are related to their respective focal lengths. It is also influenced by the mechanical tube length of the microscope. However, numerical aperture is a separate optical property that determines the resolving power and light-gathering ability, but not the direct magnification value.

157. (3) rhizoid and stalk
Hammerling's classic experiments on the giant unicellular alga Acetabularia involved the surgical exchange of parts between different species. He specifically exchanged the rhizoid, which contains the nucleus, and the stalk, which lacks a nucleus. By observing the type of cap that regenerated, he proved that the cap's characteristics were determined by the rhizoid, confirming the nucleus's role in directing development.

158. (3) fluid mosaic model.
Scientific understanding of the plasma membrane has evolved through several historical models, including the lamellar and unit membrane models. The most current and widely accepted description is the fluid mosaic model. This model portrays the membrane as a dynamic, two-dimensional liquid in which lipids and proteins are free to move laterally, accurately reflecting the membrane's biological properties and functional versatility.

159. (3) differential centrifugation
Differential centrifugation is a common laboratory technique used to separate various cellular components based on their size and density. By spinning a cell homogenate at progressively higher speeds, larger and heavier organelles like the nucleus settle first, followed by mitochondria, and finally smaller components

123. (3) ribosomes.
Ribosomes are the universal cellular machines dedicated to protein synthesis. They function as the site where messenger RNA is read and translated into a specific sequence of amino acids. This process occurs in all living cells, whether prokaryotic or eukaryotic. Ribosomes can be found floating freely in the cytoplasm or attached to the rough endoplasmic reticulum, where they produce various essential proteins.

124. (4) mesosome.
Bacteria are prokaryotic organisms and do not possess membrane-bound organelles like mitochondria for energy production. Instead, they rely on mesosomes, which are inward folds of the plasma membrane. These structures increase the available surface area for various metabolic processes, including cellular respiration. Mesosomes contain the respiratory enzymes and electron transport components required to synthesize ATP, functioning similarly to mitochondrial cristae in eukaryotes.

125. (2) hydrolytic enzymes
Lysosomes are specialized membrane-bound vesicles that serve as the primary site for intracellular digestion. They are notably rich in a wide variety of hydrolytic enzymes, which are capable of breaking down all major classes of biological molecules. These enzymes function optimally in the acidic environment maintained inside the lysosome, allowing the cell to efficiently process nutrients, recycle old organelles, and defend against pathogens.

126. (2) cell adherence
Desmosomes are specialized protein structures that act as strong cell-to-cell adhesion junctions. They are particularly abundant in tissues that experience significant mechanical stress, such as the skin and heart muscle. Desmosomes function like "spot welds," anchoring the intermediate filaments of the cytoskeleton of one cell to those of an adjacent cell, thereby providing structural integrity and strength to the entire tissue.

127. (4) Lysosomes
Among cellular organelles, lysosomes are uniquely equipped with enzymes that have powerful digestive actions. These enzymes are hydrolytic in nature and can break down complex biomolecules like proteins, lipids, and carbohydrates. This makes lysosomes essential for the cell's waste disposal and recycling system. They digest worn-out organelles, cellular debris, and foreign particles that have been engulfed by the cell, maintaining internal cellular order.

128. (4) oxidation-reduction reaction.
In mitochondria, the inner membrane is folded into many cristae, which provide a vast surface area for metabolic activities. These cristae are the primary site for the respiratory chain or electron transport chain. During aerobic respiration, a series of oxidation-reduction reactions occur along this membrane, where electrons are passed through protein complexes. This process ultimately leads to the production of ATP, the cell's energy.

129. (3) pole ward movement of chromosomes
The centromere is a vital region of the chromosome that plays a central role during mitosis and meiosis. It provides the attachment point for spindle fibers via the kinetochore. As these fibers shorten during anaphase, they exert force on the centromere, leading to the poleward movement of chromosomes. This precise mechanism ensures that each daughter cell receives the correct number of chromosomes during division.

130. (4) Golgi apparatus
The Golgi apparatus is a prominent eukaryotic organelle typically located near the nucleus. It is composed of a series of flattened, membrane-bound sacs called cisternae, which are stacked together. This organelle functions as a central processing and packaging center, where proteins and lipids synthesized in the endoplasmic reticulum are modified, sorted, and prepared for transport to their final destinations within or outside.

131. (3) cristae.
Mitochondria are enclosed by two distinct membranes. While the outer membrane is smooth, the inner membrane is highly convoluted, forming a series of inward folds known as cristae. These structures significantly increase the surface area of the inner membrane, allowing for a greater concentration of the enzymes and protein complexes involved in aerobic respiration and the efficient production of adenosine triphosphate.

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78. (1) Mitochondria - Produce cellular energy in the form of ATP
The organelle identified in the diagram is the mitochondrion, which is characterized by its double-membrane structure and internal folds called cristae. Mitochondria are the primary sites of aerobic respiration within the cell. Through complex biochemical pathways like the Krebs cycle and oxidative phosphorylation, they convert chemical energy from nutrients into adenosine triphosphate, providing the necessary power for cellular functions.

79. (4) Fluid mosaic model of cell membrane was proposed by Singer and Nicolson.
The fluid mosaic model, proposed by Singer and Nicolson in 1972, is the widely accepted description of cell membrane structure. It depicts the membrane as a quasi-fluid phospholipid bilayer in which proteins are embedded like a mosaic. This model explains how lipids and proteins can move laterally within the membrane, accounting for its dynamic nature and various physiological properties and functions.

80. (2) These are composed of ribonucleic acid and proteins.
Ribosomes are small, dense, granular organelles found in all living cells. They are unique among organelles because they are not surrounded by a membrane. Chemically, they consist of ribosomal RNA and specific proteins. They serve as the molecular machinery for protein synthesis, where they translate genetic information from mRNA into specific sequences of amino acids to form various functional polypeptide chains.

81. (4) Cell membrane
While E.coli is a prokaryotic bacterium and Chlamydomonas is a eukaryotic alga, they share a similar basic structure for their cell membrane. The plasma membrane in both organisms is a phospholipid bilayer with embedded proteins, serving as a selectively permeable barrier. Other features differ significantly, such as ribosome type (70S vs 80S), cell wall composition, and the complexity of chromosomal organization.

82. (1) Thylakoids - flattened membranous sacs forming the grana of chloroplasts
Thylakoids are essential structural units within chloroplasts, appearing as flattened, disc-like membranous sacs. They are arranged in stacks called grana, which are interconnected by stroma lamellae. The thylakoid membranes contain chlorophyll and are the primary site for the light-dependent reactions of photosynthesis. Centrioles are not for RNA synthesis, and cytoplasmic ribosomes are 80S, while lysosomes are active at acidic pH.

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83. (1) Ribosome
Ribosomes are often described as an "organelle within an organelle" because they are found not only in the cytoplasm but also inside other organelles. Specifically, mitochondria and chloroplasts possess their own 70S ribosomes, which are essential for synthesizing some of their own proteins. This unique distribution reflects the evolutionary history of these organelles and their semi-autonomous nature within the eukaryotic cell.

84. (4) ribosomes.
Ribosomes are the cellular organelles dedicated to protein synthesis. They are responsible for linking amino acids together via peptide bonds in a specific order dictated by messenger RNA. This process, known as translation, occurs in the cytoplasm or on the surface of the rough endoplasmic reticulum. Since a protein is a chain of peptides, ribosomes are the primary site for peptide synthesis.

85. (2) Golgi apparatus
The Golgi apparatus is a crucial organelle for the processing and sorting of newly synthesized macromolecules. It functions as the primary site for glycosylation, a process where sugar moieties are covalently attached to proteins and lipids. This results in the formation of glycoproteins and glycolipids, which are essential components of the cell membrane and play key roles in cell signaling and recognition.

86. (2) Peroxisome
The endomembrane system includes various membrane-bound organelles that work together to synthesize, modify, and transport cellular materials. This system comprises the endoplasmic reticulum, Golgi complex, lysosomes, and vacuoles. Peroxisomes, while membrane-bound, are not considered part of this system because they function independently in oxidative metabolism and are not physically or functionally integrated with the pathway used by the other mentioned organelles.

141. (4) formed between homologous chromosomes.
Polytene chromosomes are giant chromosomes found in the salivary glands of some fly larvae. They are formed through repeated DNA replication without cell division. A unique feature of these chromosomes is that the homologous maternal and paternal chromosomes are closely paired together throughout their length. This somatic pairing is highly regular and allows for the detailed mapping of gene locations on these chromosomes.

142. (2) very low wavelength of electron beam
The resolving power of a microscope depends on the wavelength of the radiation used. While light microscopes are limited by the wavelength of visible light, electron microscopes use a beam of electrons. Electrons have a much smaller wavelength than light, allowing the electron microscope to resolve structures that are thousands of times smaller. This enables scientists to observe the fine ultrastructure of cellular organelles.

143. (3) 0.0001 μm
Angstrom and micrometer are both units of length used to measure microscopic structures. One Angstrom is equal to ten to the power of negative ten meters. One micrometer is equal to ten to the power of negative six meters. Therefore, one Angstrom is one ten-thousandth of a micrometer, which can be expressed numerically as zero point zero zero zero one micrometers.

144. (4) can transform from one form to another.
Plastids are double-membrane organelles found in plants and algae, serving various functions such as photosynthesis and storage. Despite their diverse roles, all plastids share a common structural plan and originate from proplastids. A key feature is their ability to differentiate and transition from one type to another, such as chloroplasts turning into chromoplasts during fruit ripening, which ensures metabolic flexibility.

145. (2) nucleus in heredity
Joachim Hammerling conducted influential experiments using the giant unicellular alga Acetabularia. By exchanging the nucleus-containing rhizoids between different species, he demonstrated that the cap shape regenerated according to the source of the nucleus. This work provided early and definitive proof that the nucleus contains the genetic information that controls the development, morphology, and hereditary characteristics of a living eukaryotic cell.

146. (1) Golgi apparatus
The term "apparato reticolare interno" was the name originally given by Camillo Golgi to the organelle he discovered in 1898. Using silver staining techniques, he observed a reticular or network-like structure near the nucleus of nerve cells. This structure was later renamed the Golgi apparatus or Golgi complex in his honor. It is now recognized as a vital organelle for protein processing.

147. (1) nucleolus
Most cellular organelles are defined by a surrounding unit membrane that separates their internal environment from the cytoplasm. Mitochondria, plastids, and lysosomes are all membrane-bound structures. However, the nucleolus is a dense region of RNA and protein found within the nucleus that lacks any surrounding membrane. This allows for the free exchange of materials necessary for the active synthesis and assembly of ribosomes.

148. (2) get transformed from one type to another
Different types of plastids, including chloroplasts, chromoplasts, and leucoplasts, exhibit a similar basic internal structure and genetic makeup. This similarity exists because these organelles are developmentally related and possess the remarkable capability to transform from one form into another based on the cell's requirements. This interconvertibility ensures that plant cells can adapt their metabolic activities to changing environmental and physiological conditions.

149. (3) inner mitochondrial membrane
Oxysomes, also known as F0-F1 particles or ATP synthase complexes, are small, specialized structures located on the inner mitochondrial membrane. They are often found attached to the cristae and protrude into the mitochondrial matrix. These particles play a critical role in cellular energy production by using the proton gradient generated during electron transport to catalyze the synthesis of ATP from ADP.

150. (3) protein synthesis
Ribosomes are the primary cellular organelles responsible for the process of translation.

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96. (3) connections between adjacent cells
Plasmodesmata are specialized microscopic channels that traverse the cell walls of plant cells and some algal cells. They provide a direct cytoplasmic connection between adjacent cells, enabling the exchange of molecules such as water, ions, and small proteins. This connectivity is essential for the transport of nutrients and signaling molecules, allowing the plant to function as a coordinated multicellular organism despite rigid walls.

97. (4) glyoxysomes.
Glyoxysomes are specialized microbodies found primarily in the tissues of germinating seeds and some fungi. They contain enzymes that catalyze the glyoxylate cycle, which allows for the conversion of stored fats into carbohydrates. This process is essential during germination, as it provides the developing seedling with the energy and carbon sources necessary for growth before it can begin independent photosynthesis.

98. (4) is membrane-bound and contains water and excretory substances.
In plant cells, the vacuole is a prominent, membrane-bound organelle surrounded by a single membrane called the tonoplast. It stores cell sap, which is composed of water, dissolved minerals, sugars, and various excretory or waste products. The vacuole plays a crucial role in maintaining turgor pressure against the cell wall, which provides structural support and helps the plant remain upright and rigid.

99. (4) While lipids can rarely flip-flop, proteins cannot.
The fluid mosaic model describes the plasma membrane as a dynamic lipid bilayer. Within this bilayer, lipid molecules can easily move laterally, and they very rarely move from one monolayer to the other in a process called flip-flop movement. However, because of their large size and polar regions, membrane proteins are generally unable to perform flip-flop movements, although they move laterally.

100. (2) proline
The cell membrane is primarily composed of lipids and proteins, along with smaller amounts of carbohydrates. Common constituents include phospholipids, which form the bilayer, glycolipids involved in recognition, and cholesterol, which helps regulate membrane fluidity. Proline is a specific amino acid found in many proteins, but it is not a direct structural component of the membrane itself like the other molecules.

101. (1) Both chloroplasts and mitochondria have an internal compartment, the thylakoid space bounded by the thylakoid membrane.
Mitochondria and chloroplasts share several features, such as having a double membrane and containing their own DNA. However, they also have significant structural differences. The statement that both possess a thylakoid space is incorrect, as thylakoids are specialized internal membranes found only in chloroplasts. These thylakoids enclose a thylakoid space, whereas the inner mitochondrial membrane is folded into cristae to facilitate cellular respiration and energy production processes.

102. (2) the resolving power of the electron microscope is much higher than that of the light microscope
The development of the electron microscope revolutionized cell biology because it offered a much higher resolving power than traditional light microscopes. Resolution is the ability to distinguish two close objects as separate. Because electrons have a much shorter wavelength than visible light, an electron microscope can reveal extremely fine details of cellular organelles and molecular structures that are invisible under light.

103. (3) The enzymes of the electron transfer chain are embedded in the outer membrane.
Mitochondria are enclosed by two membranes with different properties. The outer membrane is quite permeable to various small molecules, while the inner membrane is highly selective and folded into cristae. The statement that electron transfer chain enzymes are in the outer membrane is incorrect. These enzymes, along with ATP synthase, are specifically located in the inner mitochondrial membrane where aerobic respiration occurs.

104. (2) The organised beating of cilia is controlled by fluxes of Ca^{2+} across the membrane.
Cilia are hair-like cellular extensions composed of microtubules made from tubulin. They typically show a 9+2 arrangement of microtubules in their core, known as the axoneme. While calcium ions can play a regulatory role in some signaling processes, the organized beating of cilia is primarily driven by the action of dynein motor

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like ribosomes. This method allows researchers to isolate and study specific organelles in their purified and functional states.

160. (4) cytoplasm.
Nucleoproteins are complexes consisting of proteins and nucleic acids, such as the histones that package DNA. Although these proteins function primarily within the nucleus, they are synthesized on ribosomes located in the cytoplasm, like all other cellular proteins. After synthesis, they are specifically transported across the nuclear envelope through nuclear pore complexes to reach their final destination and associate with DNA.

161. (4) several ribosomes held together by string of mRNA.
A polyribosome, or polysome, is a structural complex that forms during protein synthesis. It consists of multiple ribosomes that are simultaneously attached to and translating a single molecule of messenger RNA. This arrangement allows the cell to produce many copies of the same polypeptide chain very efficiently from a single genetic template, significantly increasing the overall rate of protein production.

162. (3) proteins, lipids and carbohydrates
The plasma membrane is a complex biological structure composed of three main types of molecules. Lipids, primarily phospholipids and cholesterol, form the fundamental structural bilayer. Proteins are embedded within this bilayer or attached to its surface, performing diverse functions such as transport and signaling. Carbohydrates are found on the outer surface, attached to lipids or proteins, where they facilitate cell recognition.

163. (3) unicellular uninucleate green algae.
Acetabularia is a genus of green algae that is remarkable for its large size and unique structure. Each individual consists of a single, giant cell that can reach several centimeters in length. It possesses only one nucleus, which is located in the rhizoid at the base. These features made it an ideal model organism for early experiments on nuclear-cytoplasmic interactions.

164. (4) phospholipids, extrinsic proteins and intrinsic proteins.
The fluid mosaic model describes the plasma membrane as a dynamic structure where proteins are embedded in a lipid bilayer. It consists of a bimolecular layer of phospholipids with their hydrophilic heads facing outwards. Extrinsic proteins are located on the surface, while intrinsic proteins are partially or totally buried within the lipid layer. This arrangement allows for the lateral movement of components.

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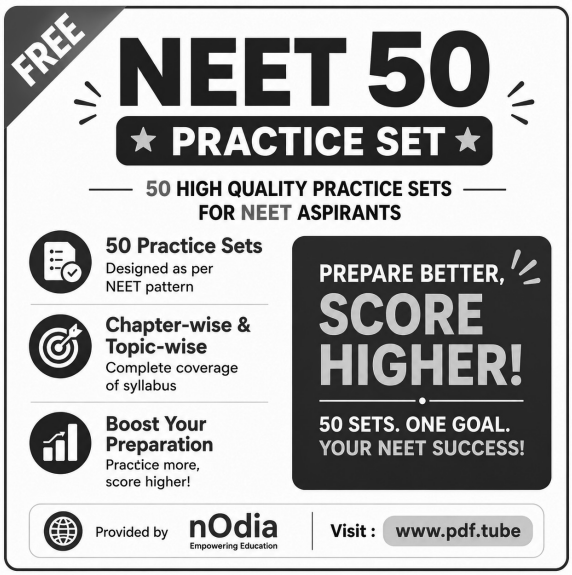

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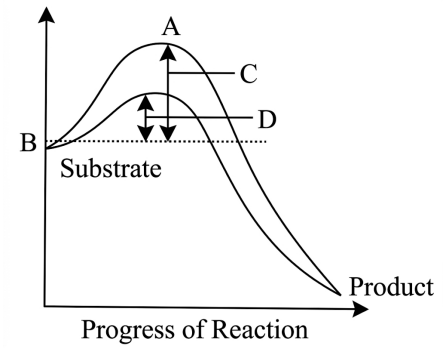
	X-axis	Y-axis
(1)	Enzymatic activity	pH
(2)	Temperature	Enzyme activity
(3)	Substrate concentration	Enzymatic activity
(4)	Enzymatic activity	Temperature

Mains 2010

74. Three of the following statements about enzymes are correct and one is wrong. Which one is wrong?
(1) Enzymes require optimum pH for maximal activity.
(2) Enzymes are denatured at high temperature but in certain exceptional organisms they are effective even at temperatures 80° - 90°C.
(3) Enzymes are highly specific.
(4) Most enzymes are proteins but some are lipids.

Mains 2010

75. The figure given below shows the conversion of a substrate into product by an enzyme. In which one of the four options (A-D) the components of reaction labelled as A, B, C and D are identified correctly?



	A	B	C	D
(1)	Potential energy	Transition state	Activation energy with enzyme	Activation energy without enzyme
(2)	Transition state	Potential energy	Activation energy without enzyme	Activation energy with enzyme
(3)	Potential energy	Transition state	Activation energy with enzyme	Activation energy without enzyme
(4)	Activation energy	Transition state	Activation energy without enzyme	Potential energy

2008

76. Carbohydrates are commonly found as starch in plants storage organs. Which of the following five properties of starch (1-5) make it useful as a storage material?
(1) Easily translocated
(2) Chemically non-reactive
(3) Easily digested by animals
(4) Osmotically inactive
(5) Synthesized during photosynthesis
The useful properties are
(1) (1), (3) and (5)
(2) (1) and (5)
(3) (2) and (3)
(4) (2) and (4).

2008

77. Cellulose is the major component of cell walls of
(1) Pseudomonas
(2) Saccharomyces
(3) Pythium
(4) Xanthomonas.

2008

78. A competitive inhibitor of succinic dehydrogenase is
(1) α-ketoglutarate
(2) malate
(3) malonate
(4) oxaloacetate.

2008

79. Modern detergents contain enzyme preparations of
(1) thermoacidophiles
(2) thermophiles
(3) acidophiles
(4) alkaliphiles.

2007

80. About 98 percent of the mass of every living organism is composed of just six elements including carbon, hydrogen, nitrogen, oxygen and
(1) sulphur and magnesium
(2) magnesium and sodium
(3) calcium and phosphorus
(4) phosphorus and sulphur.

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2006

81. An organic substance bound to an enzyme and essential for its activity is called
(1) isoenzyme
(2) coenzyme
(3) holoenzyme
(4) apoenzyme.

Identify the enzyme class 'E' from the following options :
(1) Transferases
(2) Isomerases
(3) Lyases
(4) Ligases

2025

8. Match List I with List II.

	List-I		List-II
A.	Adenosine	I.	Nitrogen base
B.	Adenylic acid	II.	Nucleotide
C.	Adenine	III.	Nucleoside
D.	Alanine	IV.	Amino acid

Choose the option with all correct matches.
(1) A-III, B-II, C-I, D-IV
(2) A-II, B-III, C-I, D-IV
(3) A-III, B-IV, C-II, D-I
(4) A-III, B-II, C-IV, D-I

2025

9. The protein portion of an enzyme is called
(1) apoenzyme
(2) prosthetic group
(3) cofactor
(4) coenzyme

2025

10. Which one of the following enzymes contains 'Haem' as the prosthetic group?
(1) Succinate dehydrogenase
(2) Catalase
(3) RuBisCO
(4) Carbonic anhydrase

2025

11. Name the class of enzyme that usually catalyse the following reaction :
S – G + S' → S + S' – G
Where, G → a group other than hydrogen
S → a substrate
S' → another substrate
(1) Transferase
(2) Ligase
(3) Hydrolase
(4) Lyase

RE-EXAM 2024

12. Which of the following is a nucleotide?
(1) Uridine
(2) Adenylic acid
(3) Guanine
(4) Guanosine

RE-EXAM 2024

13. Which of the following are not fatty acids?
A. Glutamic acid
B. Arachidonic acid
C. Palmitic acid
D. Lecithin
E. Aspartic acid
Choose the correct answer from the options given below.
(1) C, D and E only
(2) A and B only
(3) A, D and E only
(4) B and C only

2024

14. Lecithin, a small molecular weight organic compound found in living tissues, is an example of
(1) amino acids
(2) phospholipids
(3) glycerides
(4) carbohydrates.

2024

15. Match List I with List II.

	List-I		List-II
A.	GLUT-4	I.	Hormone
B.	Insulin	II.	Enzyme
C.	Trypsin	III.	Intercellular ground substance
D.	Collagen	IV.	Enables glucose transport into cells

Choose the correct answer from the options given below.
(1) A-IV, B-I, C-II, D-III
(2) A-I, B-II, C-III, D-IV
(3) A-II, B-III, C-IV, D-I
(4) A-III, B-IV, C-I, D-II

RE-EXAM 2024

16. Match List-I with List-II.

	List-I		List-II
A.	Primary structure of protein	I.	Human haemoglobin
B.	Secondary structure of protein	II.	Disulphide bonds
C.	Tertiary structure of protein	III.	Polypeptide chain
D.	Quarternary structure of protein	IV.	Alpha helix and β sheet

NODIA

2022

34. Match list-I with list-II.

List-I (Biological molecules)		List-II (Biological functions)	
(A)	Glycogen	(i)	Hormone
(B)	Globulin	(ii)	Biocatalyst
(C)	Steroids	(iii)	Antibody
(D)	Thrombin	(iv)	Storage product

Choose the correct answer from the options given below :
(1) (A)-(iii), (B)-(ii), (C)-(iv), (D)-(i)
(2) (A)-(iv), (B)-(ii), (C)-(i), (D)-(iii)
(3) (A)-(ii), (B)-(iv), (C)-(iii), (D)-(i)
(4) (A)-(iv), (B)-(iii), (C)-(i), (D)-(ii)

2021

35. Following are the statements with reference to lipids.
A. Lipids having only single bonds are called unsaturated fatty acids.
B. Lecithin is a phospholipid.
C. Trihydroxy propane is glycerol.
D. Palmitic acid has 20 carbon atoms including carboxyl carbon.
E. Arachidonic acid has 16 carbon atoms.
Choose the correct answer from the options given below.
(1) (B) and (E) only
(2) (A) and (B) only
(3) (C) and (D) only
(4) (B) and (C) only

2021

36. Which of the following are not secondary metabolites in plants?
(1) Rubber, gums
(2) Morphine, codeine
(3) Amino acids, glucose
(4) Vinblastin, curcumin

2021

37. Identify the incorrect pair.
(1) Drugs - Ricin
(2) Alkaloids - Codeine
(3) Toxin - Abrin
(4) Lectins - Concanavalin A

2020

38. Identify the basic amino acid from the following.
(1) Tyrosine
(2) Glutamic Acid
(3) Lysine
(4) Valine

2020

39. Secondary metabolites such as nicotine, strychnine and caffeine are produced by plants for their
(1) nutritive value
(2) growth response
(3) defence action
(4) effect on reproduction.

2020

40. Which one of the following is the most abundant protein in the animals?
(1) Haemoglobin (2) Collagen
(3) Lectin (4) Insulin

2020

41. Identify the substances having glycosidic bond and peptide bond, respectively in their structure.
(1) Chitin, cholesterol
(2) Glycerol, trypsin
(3) Cellulose, lecithin
(4) Inulin, insulin

2020

42. Match the following.

	Column I		Column II
(A)	Inhibitor of catalytic activity	(i)	Ricin
(B)	Possess peptide bonds	(ii)	Malonate
(C)	Cell wall material in fungi	(iii)	Chitin
(D)	Secondary metabolite	(iv)	Collagen

Choose the correct option from the following:
(1) (A)-(ii), (B)-(iv), (C)-(iii), (D)-(i)
(2) (A)-(iii), (B)-(i), (C)-(iv), (D)-(ii)
(3) (A)-(iii), (B)-(iv), (C)-(i), (D)-(ii)
(4) (A)-(ii), (B)-(iii), (C)-(i), (D)-(iv)

2019

43. Concanavalin A is
(1) a pigment
(2) an alkaloid
(3) an essential oil
(4) a lectin.

2019

44. Which of the following glucose transporters is insulin-dependent?
(1) GLUT IV (2) GLUT I
(3) GLUT II (4) GLUT III

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Manipur NEET 2023

25. Which of the following is not a secondary metabolite?
(1) Curcumin (2) Morphine
(3) Anthocyanin (4) Lecithin

Manipur NEET 2023

26. Inulin is a polymer of
(1) fructose (2) galactose
(3) amino acids (4) glucose.

2023

27. Cellulose does not form blue colour with iodine because
(1) It does not contain complex helices and hence cannot hold iodine molecules.
(2) It breaks down when iodine reacts with it.
(3) It is a disaccharide.
(4) It is a helical molecule.

2023

28. Given below are two statements:
Statement I : A protein is imagined as a line, the left end represented by first amino acid (C-terminal) and the right end represented by last amino acid (N-terminal)
Statement II : Adult human haemoglobin, consists of 4 subunits (two subunits of α type and two subunits of β type.)
In the light of the above statements, choose the correct answer from the options given below:
(1) Statement I is true but Statement II is false.
(2) Statement I is false but Statement II is true
(3) Both Statement I and Statement II are true.
(4) Both Statement I and Statement II are false.

Manipur NEET 2023, 2021

29. Match List-I with List-II.

	List-I		List-II
(p)	Protein	(i)	C = C double bonds
(q)	Unsaturated fatty acid	(ii)	Phosphodiester bonds
(r)	Nucleic acid	(iii)	Glycosidic bonds
(s)	Pol polysaccharides	(iv)	Peptide bonds

Select the correct answer from the options given below.
(1) (p)-(iv), (q)-(i), (r)-(ii), (s)-(iii)
(2) (p)-(iv), (q)-(i), (r)-(iii), (s)-(ii)
(3) (p)-(i), (q)-(iv), (r)-(iii), (s)-(ii)
(4) (p)-(ii), (q)-(i), (r)-(iv), (s)-(iii)

2023

30. Melonate inhibits the growth of pathogenic bacteria by inhibiting the activity of
(1) Lipase
(2) Dinitrogenase
(3) Succinic dehydrogenase
(4) Amylase

2023

31. Given below are two statements:
Statement I : Low temperature preserves the enzyme in a temporarily inactive state whereas high temperature destroys enzymatic activity because proteins are denatured by heat.
Statement II : When the inhibitor closely resembles the substrate in its molecular structure and inhibits the activity of the enzyme, it is known as competitive inhibitor.
In the light of the above statements, choose the correct answer from the options given below:
(1) Statement I is true but Statement II is false.
(2) Statement I is false but Statement II is true.
(3) Both Statement I and Statement II are true.
(4) Both Statement I and Statement II are false.

NODIA

2022

32. Read the following statements on lipids and find out correct set of statement.
(A) Lecithin found in the plasma membrane is a glycolipid
(B) Saturated fatty acids possess one or more C = C bonds
(C) Gingely oil has lower melting point, hence remains as oil in winter
(D) Lipids are generally insoluble in water but soluble in some organic solvents
(E) When fatty acid is esterified with glycerol, monoglycerides are formed
Choose the correct answer from the options given below.
(1) (A), (B) and (C) only
(2) (A), (D) and (E) only
(3) (C), (D) and (E) only
(4) (A), (B) and (D) only

2022

33. A dehydration reaction links two glucose molecules to produce maltose. If the formula for glucose is $C_6H_{12}O_6$ then what is the formula for maltose?
(1) $C_{12}H_{20}O_{10}$
(2) $C_{12}H_{24}O_{12}$
(3) $C_{12}H_{22}O_{11}$
(4) $C_{12}H_{24}O_{11}$

CHAPTER 09
Biomolecules

2026 (RE-NEET)

1. Match List-I with List-II:
List I:
A. Starch;
B. Antibody;
C. Concanavalin A;
D. Glut-4.

List II:
I. Fights infection,
II. Energy storage,
III. Glucose transport,
IV. Lectin

Choose the correct answer from the options given below :
(1) A-II, B-I, C-III, D-IV
(2) A-I, B-II, C-III, D-IV
(3) A-I, B-II, C-IV, D-III
(4) A-II, B-I, C-IV, D-III

2026 (RE-NEET)

2. Arrange the elements in descending order of contribution to percentage weight of the human body:
(a) Oxygen,
(b) Carbon,
(c) Hydrogen,
(d) Nitrogen.
(1) (b), (c), (d), (a)
(2) (b), (a), (c), (d)
(3) (a), (b), (c), (d)
(4) (c), (a), (b), (d)

2026 (CANCELLED)

3. Alpha-helix is found in which level of protein structure?
(1) Secondary structure
(2) Tertiary structure
(3) Primary structure
(4) Quaternary structure

2026 (CANCELLED)

4. Identify the correct statements about biomolecules.
A. Lipids are generally water soluble.
B. Proteins are polypeptides.
C. Polysaccharides are long chains of sugars.
D. Adenine and guanine are substituted pyrimidines.
E. Almost all enzymes are proteins.
Choose the correct answer from the options given below :
(1) B, D and E only
(2) B, C and E only
(3) A, B and C only
(4) C, D and E only

2026 (CANCELLED)

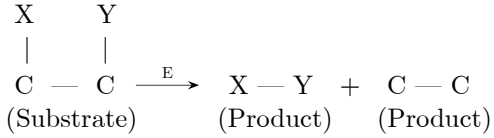
5. Which of the following statements are correct regarding amino acids?
A. They are substituted methanes.
B. Serine is an aromatic amino acid.
C. Valine is a neutral amino acid.
D. Lysine is an acidic amino acid.
Choose the correct answer from the options given below:
(1) C and D only
(2) B and C only
(3) A and C only
(4) A and B only

2026 (CANCELLED)

6. Match List I with List II:
List I:
A. Trypsin
B. Morphine
C. Concanavalin A
D. Collagen
List II:
I. Intercellular ground substance
II. Lectin
III. Enzyme
IV. Alkaloid
(1) A-III, B-IV, C-II, D-I
(2) A-I, B-II, C-III, D-IV
(3) A-IV, B-III, C-II, D-I
(4) A-III, B-II, C-IV, D-I

2026 (CANCELLED)

7. The following reaction depicts the activity of aparticular class of enzymes:



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Odisha NEET 2019

45. "Ramachandran plot" is used to confirm the structure of
(1) RNA (2) proteins
(3) triacylglycerides (4) DNA.

2019

46. Consider the following statements.
(A) Coenzyme or metal ion that is tightly bound to enzyme protein is called prosthetic group.
(B) A complete catalytic active enzyme with its bound prosthetic group is called apoenzyme.
Select the correct option.
(1) (A) is false but (B) is true.
(2) Both (A) and (B) are true.
(3) (A) is true but (B) is false.
(4) Both (A) and (B) are false.

Odisha NEET 2019

47. Prosthetic groups differ from co-enzymes in that
(1) they require metal ions for their activity
(2) they (prosthetic groups) are tightly bound to apoenzymes
(3) their association with apoenzymes is transient
(4) they can serve as co-factors in a number of enzyme-catalyzed reactions.

2018

48. The two functional groups characteristic of sugars are
(1) hydroxyl and methyl
(2) carbonyl and methyl
(3) carbonyl and phosphate
(4) carbonyl and hydroxyl.

2017

49. Which of the following are not polymeric?
(1) Proteins
(2) Polysaccharides
(3) Lipids
(4) Nucleic acids

2017

50. Which of the following statements is correct with reference to enzymes?
(1) Holoenzyme = Apoenzyme + Coenzyme
(2) Coenzyme = Apoenzyme + Holoenzyme
(3) Holoenzyme = Coenzyme + Co-factor
(4) Apoenzyme = Holoenzyme + Coenzyme

NEET-I 2016

51. A typical fat molecule is made up of
(1) one glycerol and one fatty acid molecule
(2) three glycerol and three fatty acid molecules
(3) three glycerol molecules and one fatty acid molecule
(4) one glycerol and three fatty acid molecules.

NEET-I 2016

52. Which one of the following statements is wrong?
(1) Uracil is a pyrimidine.
(2) Glycine is a sulphur containing amino acid.
(3) Sucrose is a disaccharide.
(4) Cellulose is a polysaccharide.

NEET-II 2016

53. Which of the following is the least likely to be involved in stabilising the three-dimensional folding of most proteins?
(1) Hydrogen bonds
(2) Electrostatic interaction
(3) Hydrophobic interaction
(4) Ester bonds

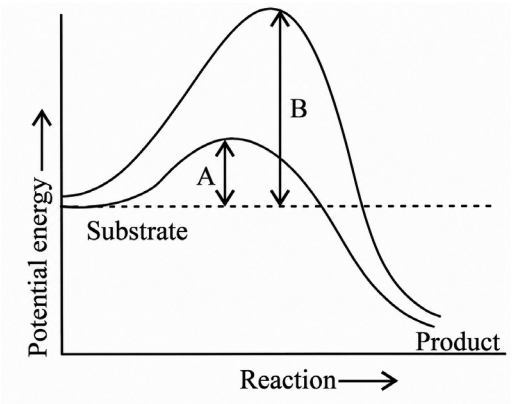
NEET-II 2016

54. A non-proteinaceous enzyme is
(1) lysozyme
(2) ribozyme
(3) ligase
(4) deoxyribonuclease.

NODIA

NEET-II 2016

55. Which of the following describes the given graph correctly?



(1) Endothermic reaction with energy A in presence of enzyme and B in absence of enzyme.
(2) Exothermic reaction with energy A in presence of enzyme and B in absence of enzyme.
(3) Endothermic reaction with energy A in absence of enzyme and B in presence of enzyme.
(4) Exothermic reaction with energy A in absence of enzyme and B in presence of enzyme.

Choose the correct answer from the options given below.
(1) A-III, B-IV, C-II, D-I
(2) A-III, B-II, C-I, D-IV
(3) A-I, B-III, C-II, D-IV
(4) A-IV, B-III, C-II, D-I

2024

17. Match List I with List II.

	List-I		List-II
A.	Lipase	I.	eptide bond
B.	Nuclease	II.	Ester bond
C.	Protease	III.	Glycosidic bond
D.	Amylase	IV.	Phosphodiester bond

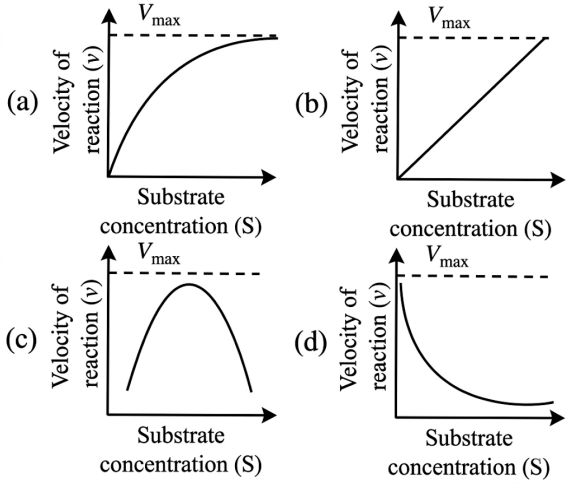
Choose the correct answer from the options given below.
(1) A-IV, B-II, C-III, D-I
(2) A-II, B-II, C-I, D-IV
(3) A-II, B-IV, C-I, D-III
(4) A-IV, B-I, C-III, D-II

RE-EXAM 2024

18. Ligases is a class of enzymes responsible for catalysing the linking together of two compounds. Which of the following bonds is not catalysed by it?
(1) C - C
(2) P - O
(3) C - O
(4) C - N

RE-EXAM 2024

19. Which of the following graphs depicts the effect of substrate concentration on velocity of enzyme catalysed reaction?



RE-EXAM 2024

20. Enzymes that catalyse the removal of groups from substrates by mechanisms other than hydrolysis leaving double bonds, are known as
(1) transferases
(2) oxidoreductases
(3) dehydrogenases
(4) lyases.

2024

21. The cofactor of the enzyme carboxypeptidase is
(1) zinc
(2) niacin
(3) flavin
(4) haem.

2024

22. Regarding catalytic cycle of an enzyme action, select the correct sequential steps.
A. Substrate enzyme complex formation.
B. Free enzyme ready to bind with another substrate.
C. Release of products.
D. Chemical bonds of the substrate broken.
E. Substrate binding to active side.
Choose the correct answer from the options given below.
(1) E, A, D, C, B
(2) A, E, B, D, C
(3) B, A, C, D, E
(4) E, D, C, B, A

2024

23. Inhibition of succinic dehydrogenase enzyme by malonate is a classical example of
(1) cofactor inhibition
(2) feedback inhibition
(3) competitive inhibition
(4) enzyme activation.

Manipur NEET 2023

24. Match List I with List II.

	List I		List II
(A)	Terpenoides	(I)	Codeine
(B)	Lectins	(II)	Diterpenes
(C)	Alkaloids	(III)	Ricin
(D)	Toxins	(IV)	Concanavalin A

Choose the correct answer from the options given below.
(1) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)
(2) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)
(3) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
(4) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

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2013

66. The essential chemical components of many coenzymes are

(1) carbohydrates (2) vitamins
(3) proteins (4) nucleic acids.

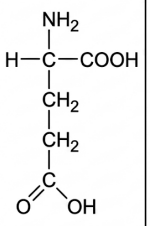
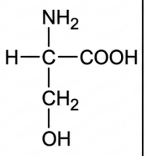
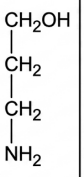
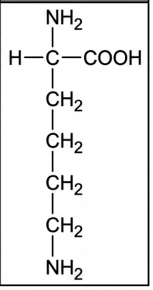
Karnataka NEET 2013

67. Which of the following statements about enzymes is wrong?

(1) Enzymes are denatured at high temperatures.
(2) Enzymes are mostly proteins but some are lipids also.
(3) Enzymes are highly specific.
(4) Enzymes require optimum pH and temperature for maximum activity.

2012

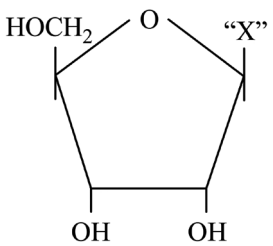
68. Which one out of A - D given below correctly represents the structural formula of the basic amino acid?

A	B	C	D
			

(1) C (2) D
(3) A (4) B

2012

69. The given diagrammatic representation shows one of the categories of small molecular weight organic compounds in the living tissues. Identify the category shown and the one blank component "X" in it.



	Category	Component
(1)	Cholesterol	Guanine
(2)	Amino acid	NH_2
(3)	Nucleotide	Adenine
(4)	Nucleoside	Uracil

NODIA

Mains 2012

70. Which one of the following biomolecules is correctly characterised?

(1) Lecithin-a phosphorylated glyceride found in cell membrane.
(2) Palmitic acid - an unsaturated fatty acid with 18 carbon atoms.
(3) Adenylic acid - adenosine with a glucose phosphate molecule.
(4) Alanine amino acid - contains an amino group and an acidic group anywhere in the molecule.

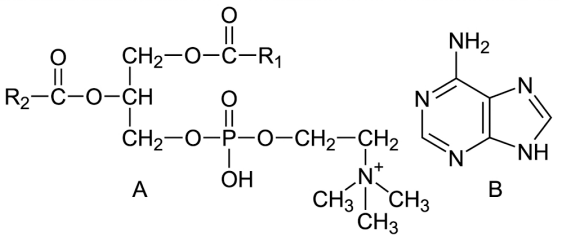
2012

71. Which one is the most abundant protein in the animal world?

(1) Trypsin
(2) Haemoglobin
(3) Collagen
(4) Insulin

2011

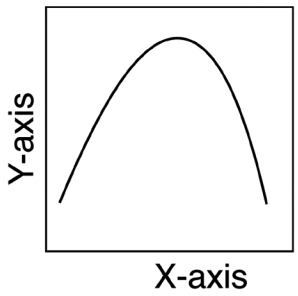
72. Which one of the following structural formulae of two organic compounds is correctly identified along with its related function?



(1) B : Adenine - A nucleotide that makes up nucleic acids
(2) A : Triglyceride - Major source of energy
(3) B : Uracil - A component of DNA
(4) A : Lecithin - A component of cell membrane

2011

73. The curve given below shows enzymatic activity in relation to three conditions (pH, temperature and substrate concentration). What do the two axes (X and Y) represent?



2015

56. The chitinous exoskeleton of arthropods is formed by the polymerisation of
(1) N - acetyl glucosamine
(2) lipoglycans
(3) keratin sulphate and chondroitin sulphate
(4) D - glucosamine.

2015

57. Which of the following biomolecules does have a phosphodiester bond?
(1) Amino acids in a polypeptide
(2) Nucleic acids in a nucleotide
(3) Fatty acids in a diglyceride
(4) Monosaccharides in a polysaccharide

2015 Cancelled

58. Which one of the following statements is incorrect?
(1) The competitive inhibitor does not affect the rate of breakdown of the enzyme-substrate complex.
(2) The presence of the competitive inhibitor decreases the Km of the enzyme for the substrate.
(3) A competitive inhibitor reacts reversibly with the enzyme to form an enzyme-inhibitor complex.
(4) In competitive inhibition, the inhibitor molecule is not chemically changed by the enzyme.

2014

59. Which one of the following is a non - reducing carbohydrate?
(1) Maltose
(2) Sucrose
(3) Lactose
(4) Ribose 5-phosphate

2014

60. Select the option which is not correct with respect to enzyme action.
(1) Substrate binds with enzyme at its active site.
(2) Addition of lot of succinate does not reverse the inhibition of succinic dehydrogenase by malonate.
(3) A non-competitive inhibitor binds the enzyme at a site distinct from that which binds the substrate.
(4) Malonate is a competitive inhibitor of succinic dehydrogenase.

2013

61. A phosphoglyceride is always made up of
(1) a saturated or unsaturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached
(2) a saturated or unsaturated fatty acid esterified to a phosphate group which is also attached to a glycerol molecule
(3) only a saturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached
(4) only an unsaturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached.

Karnataka NEET 2013

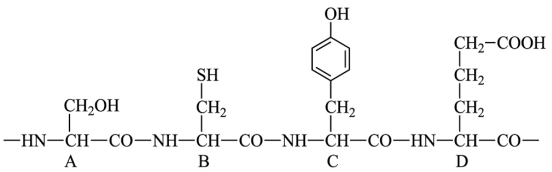
62. Uridine, present only in RNA is a
(1) nucleoside
(2) nucleotide
(3) purine
(4) pyrimidine.

2013

63. Macromolecule chitin is
(1) sulphur containing polysaccharide
(2) simple polysaccharide
(3) nitrogen containing polysaccharide
(4) phosphorus containing polysaccharide.

Karnataka NEET 2013

64. The figure shows a hypothetical tetrapeptide portion of a protein with parts labelled A-D. Which one of the following options is correct?



(1) D is the acidic amino acid-glutamic acid.
(2) C is an aromatic amino acid-tryptophan.
(3) A is the C-terminal amino acid and D is N-terminal amino acid.
(4) A is a sulphur containing amino acid methionine.

2013

65. Transition state structure of the substrate formed during an enzymatic reaction is
(1) transient and unstable
(2) permanent and stable
(3) transient but stable
(4) permanent but unstable.

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2005

82. Which of the following is the simplest amino acid?
(1) Alanine
(2) Asparagine
(3) Glycine
(4) Tyrosine

2005

83. Carbohydrates, the most abundant biomolecule on earth, are produced by
(1) some bacteria, algae and green plant cells
(2) fungi, algae and green plant cells
(3) all bacteria, fungi and algae
(4) viruses, fungi and bacteria.

2005

84. Nucleotides are building blocks of nucleic acids. Each nucleotide is a composite molecule formed by
(1) base-sugar-phosphate
(2) base-sugar-OH
(3) (base-sugar-phosphate)n
(4) sugar-phosphate.

2005

85. The catalytic efficiency of two different enzymes can be compared by the
(1) formation of the product
(2) pH of optimum value
(3) Km value
(4) molecular size of the enzyme.

2005

86. Which one of the following statements regarding enzyme inhibition is correct?
(1) Competitive inhibition is seen when a substrate competes with an enzyme for binding to an inhibitor protein.
(2) Competitive inhibition is seen when the substrate and the inhibitor compete for the active site on the enzyme.
(3) Non-competitive inhibition of an enzyme can be overcome by adding large amount of substrate.
(4) Non-competitive inhibitors often bind to the enzyme irreversibly.

2005

87. Enzymes, vitamins and hormones can be classified into a single category of biological chemicals, because all of these
(1) help in regulating metabolism
(2) are exclusively synthesised in the body of a living organism as at present
(3) are conjugated proteins
(4) enhance oxidative metabolism.

2004

88. In which one of the following enzymes, is copper necessarily associated as an activator?
(1) Carbonic anhydrase
(2) Tryptophanase
(3) Lactic dehydrogenase
(4) Tyrosinase

2003

89. The major role of minor elements inside living organisms is to act as
(1) co-factors of enzymes
(2) building blocks of important amino acids
(3) constituent of hormones
(4) binder of cell structure.

2002

90. Lipids are insoluble in water because lipid molecules are
(1) hydrophilic
(2) hydrophobic
(3) neutral
(4) zwitter ions.

2002

91. Which of the following is a reducing sugar?
(1) Galactose
(2) Gluconic acid
(3) β-methyl galactoside
(4) Sucrose

2001

92. Spoilage of oil can be detected by which fatty acid?
(1) Oleic acid
(2) Linolenic acid
(3) Linoleic acid
(4) Erucic acid

2000

93. Essential amino acid is
(1) phenylalanine
(2) glycine
(3) aspartic acid
(4) serine.

2000

94. Which of the following have carbohydrate as prosthetic group?
(1) Glycoprotein
(2) Chromoprotein
(3) Lipoprotein
(4) Nucleoprotein

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40. (2) Collagen
Collagen is a fibrous structural protein that serves as a major component of connective tissues, including cartilage, tendons, bones, and skin. It provides essential strength and structural support throughout the body. Due to its presence in almost all animal tissues and its critical role in maintaining biological structure, collagen is recognized as the most abundant protein found within the entire animal kingdom.

41. (4) Inulin, insulin
Different types of biological polymers are defined by the bonds that link their subunits. Inulin is a polysaccharide made of fructose units joined by glycosidic bonds. Insulin is a peptide hormone composed of amino acids linked together by peptide bonds. This pair correctly identifies a substance containing glycosidic bonds followed by one containing peptide bonds, whereas the other options mix lipids, proteins, and carbohydrates.

42. (1) (A)-(ii), (B)-(iv), (C)-(iii), (D)-(i)
Biomolecules are characterized by their specific properties and biological functions. Malonate serves as a competitive inhibitor of enzyme activity. Collagen is a structural protein held together by peptide bonds. Chitin is the primary structural material found in the cell walls of fungi. Ricin is a toxic compound classified as a secondary metabolite. Together, these examples illustrate the chemical diversity and functional specialization of organic compounds in nature.

43. (4) a lectin.
Concanavalin A is a protein derived from the jack bean plant. It belongs to the group of molecules known as lectins, which are characterized by their ability to bind specifically to certain carbohydrate structures. This property makes concanavalin A a useful tool in biological research for studying cell surface glycoproteins and for stimulating the proliferation of certain types of immune cells.

44. (1) GLUT IV
Glucose transporters are specialized proteins that facilitate the movement of glucose across cell membranes. While some transporters function independently of hormones, GLUT IV is specifically regulated by insulin. In the presence of insulin, GLUT IV is translocated from intracellular vesicles to the plasma membrane, primarily in muscle and adipose tissues, allowing for the efficient uptake of glucose from the bloodstream into these cells.

45. (2) proteins
The Ramachandran plot is a fundamental tool used in structural biology to visualize the dihedral angles of the polypeptide backbone. By plotting these angles, researchers can identify the allowed and disallowed conformations of amino acids within a protein. This analysis is essential for confirming the stability and accuracy of three-dimensional protein structures determined through experimental methods like X-ray crystallography or NMR spectroscopy.

46. (3) (A) is true but (B) is false.
A prosthetic group is a non-protein cofactor that is tightly and permanently bound to an enzyme to enable its catalytic activity. The protein part of the enzyme alone is known as the apoenzyme. When the apoenzyme is combined with its required cofactor or prosthetic group, the resulting complete and catalytically active enzyme is referred to as a holoenzyme, not an apoenzyme.

47. (2) they (prosthetic groups) are tightly bound to apoenzymes
Cofactors are non-protein substances required for enzyme activity and include both co-enzymes and prosthetic groups. The primary difference between them lies in the strength of their association with the protein part of the enzyme, known as the apoenzyme. While co-enzymes associate only transitionally during catalysis, prosthetic groups are permanently and tightly bound to the apoenzyme, ensuring the enzyme remains functional at all times.

NODIA

48. (4) carbonyl and hydroxyl.
Sugars, also known as carbohydrates, are chemically defined as polyhydroxy aldehydes or ketones. This means their molecular structure always features multiple hydroxyl groups attached to a carbon backbone. Additionally, they contain a carbonyl group, which exists either as an aldehyde group at the end of the chain or as a ketone group within the chain, determining the sugar's chemical properties and reactivity.

49. (3) Lipids
Most biological macromolecules, such as proteins, polysaccharides, and nucleic acids, are polymers

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(3) Length of one helix is 45 Å in B-DNA.
(4) One turn of Z-DNA has 12 bases.

1992

109. Amino acids are mostly synthesised from
(1) mineral salts
(2) fatty acids
(3) volatile acids
(4) α-ketoglutaric acid.

1992

110. Living cell contains 60 - 95% water. Water present in human body is
(1) 60 - 65%
(2) 50 - 55%
(3) 75 - 80%
(4) 65 - 70%.

1992

111. In RNA, thymine is replaced by
(1) adenine
(2) guanine
(3) cytosine
(4) uracil.

1992

112. Adenine is
(1) purine
(2) pyrimidine
(3) nucleoside
(4) nucleotide.

1991

113. A nucleotide is formed of
(1) purine, pyrimidine and phosphate
(2) purine, sugar and phosphate
(3) nitrogen base, sugar and phosphate
(4) pyrimidine, sugar and phosphate.

1991

114. DNA is composed of repeating units of
(1) ribonucleosides
(2) deoxyribonucleosides
(3) ribonucleotides
(4) deoxyribonucleotides.

1991

115. The basic unit of nucleic acid is
(1) pentose sugar
(2) nucleoid
(3) nucleoside
(4) nucleotide.

1991

116. A segment of DNA has 120 adenine and 120 cytosine bases. The total number of nucleotides present in the segment is
(1) 120
(2) 240
(3) 60
(4) 480.

1991

117. Enzymes having slightly different molecular structure but performing identical activity are
(1) holoenzymes
(2) isoenzymes
(3) apoenzymes
(4) coenzymes.

1990

118. Which is not consistent with double helical structure of DNA?
(1) A = T, C = G
(2) Density of DNA decreases on heating.
(3) A + T/C + G is not constant.
(4) Both (a) and (b)

1988

119. RNA does not possess
(1) uracil
(2) thymine
(3) adenine
(4) cytosine.

1988

120. In double helix of DNA, the two DNA strands are
(1) coiled around a common axis
(2) coiled around each other
(3) coiled differently
(4) coiled over protein sheath.

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2000

95. ATP is
(1) nucleotide
(2) nucleoside
(3) nucleic acid
(4) vitamin.

2000

96. Role of an enzyme in reactions is to/as
(1) decrease activation energy
(2) increase activation energy
(3) inorganic catalyst
(4) none of the above.

2000

97. Which factor is responsible for inhibition of enzymatic process during feedback?
(1) Substrate
(2) Enzymes
(3) End product
(4) Temperature

2000

98. Enzymes are not found in
(1) fungi
(2) algae
(3) virus
(4) cyanobacteria.

1998

99. Cellulose, the most important constituent of plant cell wall is made up of
(1) branched chain of glucose molecules linked by β-1, 4 glycosidic bond in straight chain and α-1, 6 glycosidic bond at the site of branching
(2) unbranched chain of glucose molecules linked by β-1, 4 glycosidic bond
(3) branched chain of glucose molecules linked by α-1, 6 glycosidic bond at the site of branching
(4) unbranched chain of glucose molecules linked by α-1, 4 glycosidic bond.

1998

100. Lactose is composed of
(1) glucose + galactose
(2) fructose + galactose
(3) glucose + fructose
(4) glucose + glucose.

1997

101. Co-factor (prosthetic group) is a part of holoenzyme. It is
(1) loosely attached organic part
(2) loosely attached inorganic part
(3) accessory non-protein substance attached firmly
(4) none of these.

1996

102. What are the most diverse molecules in the cell?
(1) Lipids
(2) Mineral salts
(3) Proteins
(4) Carbohydrates

1996

103. In which of the following groups are all polysaccharides?
(1) Sucrose, glucose and fructose
(2) Maltose, lactose and fructose
(3) Glycogen, sucrose and maltose
(4) Glycogen, cellulose and starch

1996

104. Which purine base is found in RNA?
(1) Thymine
(2) Uracil
(3) Cytosine
(4) Guanine

NODIA

1996

105. Which is a typical example of 'feedback inhibition'?
(1) Cyanide and cytochrome reaction
(2) Sulpha drugs and folic acid synthesizer bacteria
(3) Allosteric inhibition of hexokinase by glucose 6-phosphate
(4) Reaction between succinic dehydrogenase and succinic acid

1994

106. Which of the following nucleotide sequences contains 4 pyrimidine bases?
(1) GATCAATGC
(2) GCUAGACAA
(3) UACCGGUAA
(4) Both (b) and (c)

1993

107. Glycogen is a polymer of
(1) galactose
(2) glucose
(3) fructose
(4) sucrose.

1993

108. Which is wrong about nucleic acids?
(1) DNA is single stranded in some viruses.
(2) RNA is double stranded occasionally.

12. (2) Adenylic acid
Nucleotides are the basic building blocks of nucleic acids and consist of a nitrogenous base, a pentose sugar, and a phosphate group. Adenylic acid is a nucleotide formed when a phosphate group is attached to the nucleoside adenosine. In contrast, guanine is a nitrogenous base, while uridine and guanosine are nucleosides that lack the required phosphate group for classification.

13. (3) A, D and E only
Fatty acids are long-chain hydrocarbons with a terminal carboxylic acid group. Arachidonic acid and palmitic acid are classic examples of these lipid components. Glutamic acid and aspartic acid are amino acids used in protein synthesis, while lecithin is a complex phospholipid found in cell membranes. Therefore, amino acids and phospholipids do not fall under the specific category of fatty acids.

14. (2) phospholipids
Lecithin is a vital organic compound found within the cell membranes of living tissues. It is classified as a phospholipid because its structure contains a glycerol backbone esterified to two fatty acids and a phosphate group linked to choline. This amphipathic nature allows lecithin to play a crucial role in maintaining the structural integrity and fluidity of biological membranes in organisms.

15. (1) A-IV, B-I, C-II, D-III
Biomolecules perform diverse roles in living systems. Collagen is a fibrous protein acting as an intercellular ground substance. Trypsin is a digestive enzyme that breaks down proteins. Insulin is a peptide hormone regulating blood sugar levels. GLUT-4 is a specialized transport protein that enables the movement of glucose into cells. Each of these molecules is essential for maintaining physiological homeostasis.

16. (1) A-III, B-IV, C-II, D-I
Proteins exhibit four levels of structural organization. The primary structure refers to the linear sequence of amino acids in a polypeptide chain. The secondary structure includes localized folding like alpha helices and beta sheets. The tertiary structure is the three-dimensional shape stabilized by bonds like disulphide bridges. The quaternary structure involves multiple polypeptide subunits, as seen in the human haemoglobin molecule.

17. (3) A-II, B-IV, C-I, D-III
Different enzymes target specific chemical bonds within their substrates. Lipases catalyze the breakdown of ester bonds in lipids. Nucleases act on the phosphodiester bonds that link nucleotides in nucleic acids. Proteases are responsible for cleaving peptide bonds between amino acids in proteins. Amylase targets the glycosidic bonds found in carbohydrates like starch to release simpler sugars during the process of digestion.

18. (1) C - C
Ligases are a specific class of enzymes that facilitate the joining of two molecules by forming new chemical bonds. They typically catalyze the linking of bonds such as carbon-oxygen, carbon-sulphur, carbon-nitrogen, and phosphorus-oxygen. While other enzymes like lyases or transferases might involve carbon-carbon interactions, the standard definition of ligases in biological systems does not primarily include the catalysis of C-C bonds.

19. (1) Graph of Velocity of reaction (v) on Y-axis and Substrate concentration (S) on X-axis showing rectangular hyperbola curve
The relationship between the rate of an enzyme-catalyzed reaction and substrate concentration follows a specific pattern. Initially, the velocity increases rapidly as more substrate is added. However, as the enzyme molecules become saturated, the reaction rate levels off, reaching a maximum velocity called Vmax. This characteristic saturation kinetics is mathematically and graphically represented as a rectangular hyperbola on a coordinate plane.

20. (4) lyases.
Lyases are a class of enzymes that catalyze the removal of specific groups from their substrates through mechanisms other than hydrolysis. This catalytic action results in the formation of double bonds within the remaining molecular structure. Unlike hydrolases, which use water to break bonds, lyases break chemical bonds by different means, playing a distinct role in various metabolic pathways and cellular processes.

21. (1) zinc
Many enzymes require the presence of metal ions as cofactors to achieve full catalytic activity. Carboxypeptidase, a proteolytic enzyme involved in protein digestion, specifically requires zinc ions for its function. The metal ion is typically

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is needed to reach half-maximum velocity. Therefore, stating that a competitive inhibitor decreases the Km is incorrect, as it actually reduces the enzyme's apparent affinity.

59. (2) Sucrose
Reducing sugars are carbohydrates that have a free aldehyde or ketone group, allowing them to act as reducing agents. Maltose, lactose, and ribose possess these groups and are therefore reducing. Sucrose, however, is a non-reducing disaccharide because the glycosidic bond forms between the anomeric carbons of glucose and fructose, effectively masking their reducing groups and preventing them from reacting in standard tests.

60. (2) Addition of lot of succinate does not reverse the inhibition of succinic dehydrogenase by malonate.
Competitive inhibition, such as that caused by malonate on succinic dehydrogenase, depends on the relative concentrations of the substrate and the inhibitor. Because they compete for the same active site, increasing the concentration of the natural substrate, succinate, can displace the inhibitor and restore enzyme activity. Therefore, the claim that adding more succinate does not reverse the inhibition is incorrect regarding the mechanism.

61. (1) a saturated or unsaturated fatty acid esterified to a glycerol molecule to which a phosphate group is also attached
Phosphoglycerides are a major class of phospholipids found in biological membranes. Their structure consists of a glycerol backbone where two hydroxyl groups are esterified to fatty acids, which can be either saturated or unsaturated. The third hydroxyl group is linked to a phosphate group, which is often further attached to another polar molecule, creating the amphipathic nature essential for forming lipid bilayers.

62. (1) nucleoside
Uridine is a specific molecule found in RNA that consists of the nitrogenous base uracil attached to a ribose sugar. Because it lacks a phosphate group, it is classified as a nucleoside. Once a phosphate group is added to uridine, it becomes a nucleotide known as uridylic acid. Uridine is unique to RNA, as DNA uses deoxythymidine instead of uridine for its genetic structure.

63. (3) nitrogen containing polysaccharide
Chitin is a complex structural macromolecule found in the exoskeletons of arthropods and the cell walls of fungi. Chemically, it is a homopolysaccharide composed of repeating units of N-acetyl glucosamine. Because each monomer contains an acetylamino group, chitin is specifically categorized as a nitrogen-containing polysaccharide. This composition distinguishes it from simpler polysaccharides like cellulose or starch, which are composed only of carbon, hydrogen, and oxygen.

64. (1) D is the acidic amino acid-glutamic acid.
Proteins are composed of various amino acids with distinct side chains. In a polypeptide, specific residues can be identified by their chemical properties. Glutamic acid is an acidic amino acid characterized by a carboxyl group in its side chain, which is typically represented in structural diagrams of peptides. Identifying such acidic, basic, or aromatic residues is crucial for understanding the protein's overall charge and chemical behavior.

65. (1) transient and unstable
During an enzymatic reaction, the substrate must be converted into a product by passing through a high-energy state. This intermediate phase is known as the transition state structure. It is characterized by being highly transient and unstable, existing only for a fraction of a second as chemical bonds are being broken and formed. The enzyme facilitates the reaction by stabilizing this high-energy state.

66. (2) vitamins
Coenzymes are non-protein organic molecules that assist enzymes in their catalytic functions. Many coenzymes are derived from vitamins, which are essential micronutrients that the body cannot synthesize in sufficient quantities. For example, nicotinamide adenine dinucleotide (NAD) and flavin adenine dinucleotide (FAD) contain B-vitamins. These components are vital for the proper transfer of electrons and groups during various metabolic reactions in the cell.

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67. (2) Enzymes are mostly proteins but some are lipids also.
Enzymes are biological catalysts that are almost exclusively proteinaceous in nature. While some catalytic molecules made of RNA, called ribozymes, have been discovered, enzymes are

growth and providing a classic example of competitive enzyme inhibition.

31. (3) Both Statement I and Statement II are true.
Enzymes are highly sensitive to temperature changes; low temperatures lead to temporary inactivity, while high temperatures cause permanent denaturation of the protein structure. Additionally, competitive inhibition occurs when an inhibitor molecule mimics the substrate's shape and competes for the active site. Both statements accurately reflect fundamental principles of enzymology regarding the factors that influence catalytic activity and the mechanism of inhibition.

32. (3) (C), (D) and (E) only
Lipids exhibit diverse physical and chemical properties. Gingely oil remains liquid in winter due to its low melting point. Lipids are generally hydrophobic and dissolve only in organic solvents. Monoglycerides form through the esterification of a single fatty acid with glycerol. Conversely, lecithin is a phospholipid rather than a glycolipid, and saturated fatty acids lack double bonds, containing only single carbon-carbon bonds.

33. (3) $C_{12}H_{22}O_{11}$
When two glucose molecules, each with the formula $C_6H_{12}O_6$, join to form the disaccharide maltose, a dehydration synthesis reaction occurs. This process involves the removal of one water molecule (H_2O) to link the monomers. By adding the atoms of two glucose units and subtracting the atoms of one water molecule, the resulting chemical formula for maltose is determined to be $C_{12}H_{22}O_{11}$.

34. (4) (A)-(iv), (B)-(iii), (C)-(i), (D)-(ii)
Biological molecules serve specific functional roles in organisms. Glycogen is a primary storage polysaccharide in animals. Globulins are proteins that can function as antibodies in the immune system. Many steroids act as hormones, regulating various physiological processes. Thrombin is a proteolytic enzyme that acts as a biocatalyst in the blood-clotting cascade, converting fibrinogen into fibrin to form a stable blood clot.

35. (4) (B) and (C) only
Lipids are diverse molecules with specific structural definitions. Lecithin is a well-known phospholipid essential for cell membranes, and glycerol is chemically identified as trihydroxy propane. However, fatty acids with only single bonds are called saturated, not unsaturated. Additionally, palmitic acid contains 16 carbons, while arachidonic acid contains 20 carbons. Therefore, only the descriptions of lecithin and glycerol provided in the options are correct.

36. (3) Amino acids, glucose
Primary metabolites like amino acids and glucose are essential for the basic physiological processes of plants, including growth and metabolism. Secondary metabolites, however, are not directly required for survival but provide ecological benefits. Morphine, codeine, rubber, gums, vinblastin, and curcumin are all examples of secondary metabolites. Since amino acids and glucose are fundamental building blocks of life, they do not belong to this category.

37. (1) Drugs - Ricin
Secondary metabolites are categorized based on their chemical nature and biological effects. Codeine is an alkaloid, abrin and ricin are potent toxins, and concanavalin A is a lectin. While some secondary metabolites are used as drugs, ricin is specifically classified as a toxin in biological contexts. Therefore, pairing ricin with the general category of drugs is incorrect when compared to the specific classifications.

38. (3) Lysine
Amino acids are classified as acidic, basic, or neutral based on the properties of their side chains. Lysine is a basic amino acid because it contains an additional amino group in its side chain, which can accept a proton. In contrast, glutamic acid is acidic, tyrosine is an aromatic amino acid, and valine is a neutral, non-polar amino acid used in protein synthesis.

39. (3) defence action
Secondary metabolites like nicotine, strychnine, and caffeine are produced by plants primarily as a defense mechanism against herbivores and pathogens. These chemical compounds often have toxic or repellent effects on animals that might otherwise consume the plant. While they do not play a direct role in primary growth or reproduction, they provide a significant survival advantage by protecting the plant from environmental threats.

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ANSWERS

1. (4) A-II, B-I, C-IV, D-III
Starch is for energy storage (II). Antibodies fight infection (I). Concanavalin A is a lectin (IV). Glut-4 is a glucose transporter (III). This gives A-II, B-I, C-IV, D-III.

2. (3) (a), (b), (c), (d)
By percentage weight, oxygen is most abundant (~65%), followed by carbon (~18%), hydrogen (~10%), and nitrogen (~3%). This descending order corresponds to oxygen, carbon, hydrogen, nitrogen.

3. (1) Secondary structure
The alpha-helix is a coiled arrangement of the polypeptide chain stabilised by hydrogen bonds, representing the secondary structure of a protein. Primary structure is the amino acid sequence, tertiary is the 3D folding, and quaternary involves the assembly of multiple polypeptide subunits.

4. (2) B, C and E only
Proteins are polypeptides (B correct), polysaccharides are long sugar chains (C correct), and almost all enzymes are proteins (E correct). Lipids are not water soluble, so A is wrong. Adenine and guanine are substituted purines, not pyrimidines, so D is wrong.

5. (3) A and C only
Amino acids can be regarded as substituted methanes, where the central carbon bears four groups (A correct). Valine is a neutral amino acid (C correct). Serine is not aromatic; it is an aliphatic hydroxyl amino acid (B wrong). Lysine is basic, not acidic (D wrong).

6. (1) A-III, B-IV, C-II, D-I
Trypsin is a digestive enzyme (III). Morphine is an alkaloid obtained from opium (IV). Concanavalin A is a lectin, a carbohydrate-binding protein (II). Collagen forms the intercellular ground substance of connective tissue (I). This gives the match A-III, B-IV, C-II, D-I.

7. (3) Lyases
The reaction shows removal of two groups (X and Y) from adjacent carbons of the substrate, forming a double bond (C=C) along with the product X-Y. This elimination, without hydrolysis, that creates a double bond is characteristic of lyases, which cleave bonds by means other than hydrolysis or oxidation.

8. (1) A-III, B-II, C-I, D-IV
Biomolecules are categorized based on their chemical structure and components. Adenosine consists of adenine and ribose sugar, making it a nucleoside. Adenylic acid includes a phosphate group, defining it as a nucleotide. Adenine is a nitrogenous base belonging to the purine group. Alanine is a simple organic molecule containing amino and carboxyl groups, identifying it as an amino acid.

9. (1) apoenzyme
Enzymes are often composed of a protein portion and a non-protein part. The protein part of such a complex enzyme is specifically referred to as the apoenzyme. This component is catalytically inactive on its own and requires the binding of specific organic or inorganic cofactors to become a fully functional holoenzyme, which then facilitates various biochemical reactions in cells.

10. (2) Catalase
Certain enzymes require non-protein components called prosthetic groups for their catalytic activity. Haem is an essential prosthetic group found in the active sites of enzymes like catalase and peroxidase. These enzymes are vital for breaking down hydrogen peroxide into water and oxygen, protecting the cell from oxidative damage. Haem is also a characteristic component of the oxygen-carrying protein haemoglobin.

11. (1) Transferase
Enzymes are classified into groups based on the type of reaction they facilitate. Transferases are a class of enzymes that catalyze the movement of a specific functional group, other than hydrogen, from one substrate molecule to another. This process is essential in many metabolic pathways where groups like phosphate, methyl, or amino groups are relocated between different molecules for biosynthesis.

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formed by the repetitive linking of smaller monomeric units. Proteins are made of amino acids, polysaccharides of monosaccharides, and nucleic acids of nucleotides. In contrast, lipids are not considered true polymers because they are composed of distinct molecules like glycerol and fatty acids rather than long chains of repeating monomers.

50. (1) Holoenzyme = Apoenzyme + Coenzyme
A functional enzyme often consists of multiple components. The apoenzyme is the protein part, which is inactive on its own. To become active, it must bind with a cofactor, such as a coenzyme or a prosthetic group. The complete, catalytically active unit formed by the combination of the apoenzyme and its required cofactor is known as the holoenzyme, which performs biochemical reactions.

51. (4) one glycerol and three fatty acid molecules.
A typical fat molecule, specifically a triglyceride, is formed through a dehydration synthesis reaction. In this process, a single molecule of glycerol, which is a trihydroxy alcohol, reacts with three individual fatty acid molecules. Each hydroxyl group of the glycerol forms an ester bond with the carboxyl group of a fatty acid, resulting in the final structure of the fat molecule.

52. (2) Glycine is a sulphur containing amino acid.
Biomolecules have specific chemical identities. Uracil is a pyrimidine found in RNA. Sucrose is a disaccharide made of glucose and fructose. Cellulose is a structural polysaccharide in plants. However, glycine is the simplest amino acid and does not contain sulphur; its side chain is a single hydrogen atom. Sulphur-containing amino acids are specifically cysteine and methionine, which contain thiol or thioether groups.

53. (4) Ester bonds
The three-dimensional folding and stability of proteins are maintained by several types of chemical interactions. These include hydrogen bonds, electrostatic interactions between charged side chains, hydrophobic interactions among non-polar groups, and disulphide bridges. Ester bonds are typically found in lipids like triglycerides and are not a standard feature involved in stabilizing the tertiary or quaternary structures of most globular or fibrous proteins.

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54. (2) ribozyme
While the vast majority of enzymes are proteins, some catalytic molecules are made of ribonucleic acid. These non-proteinaceous enzymes are called ribozymes. They play critical roles in cellular processes, such as splicing RNA transcripts and facilitating peptide bond formation within the ribosome during protein synthesis. Other enzymes like lysozyme, ligase, and deoxyribonuclease are entirely composed of polypeptide chains and are thus proteinaceous.

55. (4) Exothermic reaction with energy A in absence of enzyme and B in presence of enzyme.
In an exothermic reaction, the products have lower potential energy than the substrates, releasing energy. Enzymes accelerate these reactions by lowering the activation energy barrier. The graph shows that the energy required to reach the transition state is much higher without a catalyst than with one. Thus, label A represents the activation energy without an enzyme, and label B represents it with an enzyme.

56. (1) N - acetyl glucosamine
Chitin is a tough, protective polysaccharide that forms the structural component of the exoskeleton in arthropods and the cell walls of fungi. It is a homopolymer produced by the polymerization of N-acetyl glucosamine units linked by beta-glycosidic bonds. This molecular structure provides significant mechanical strength and chemical resistance, which are essential for protecting the internal tissues of insects, crabs, and related organisms.

57. (2) Nucleic acids in a nucleotide
Phosphodiester bonds are the chemical links that form the backbone of nucleic acids like DNA and RNA. These bonds connect the phosphate group of one nucleotide to the hydroxyl group on the third carbon of the pentose sugar of the adjacent nucleotide. While proteins use peptide bonds and polysaccharides use glycosidic bonds, the phosphodiester bond is the characteristic linkage for joining nucleotides into long chains.

58. (2) The presence of the competitive inhibitor decreases the Km of the enzyme for the substrate.
Competitive inhibition occurs when an inhibitor competes with the substrate for the enzyme's active site. This process is reversible and does not change the maximum reaction velocity, but it does increase the Km value, as more substrate

coordinated to specific amino acid side chains at the active site, where it assists in stabilizing the substrate or participating directly in the chemical reaction mechanism.

22. (1) E, A, D, C, B
The catalytic cycle begins when a substrate binds to the active site of an enzyme. This leads to the formation of a substrate-enzyme complex, inducing the enzyme to wrap more tightly around the substrate. Subsequently, chemical bonds within the substrate are broken, forming the product. Finally, the products are released, and the free enzyme becomes available to bind with another substrate.

23. (3) competitive inhibition
Competitive inhibition occurs when a molecule closely resembling the substrate competes for binding at the enzyme's active site. Malonate is a structural analogue of succinate and competes with it for the active site of succinic dehydrogenase. This binding prevents the substrate from being processed, thereby reducing the reaction rate. Such inhibition can typically be overcome by significantly increasing the substrate concentration.

24. (4) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)
Secondary metabolites are chemicals produced by plants that are not directly involved in primary growth. Diterpenes are classified as terpenoids, while codeine is a well-known alkaloid. Concanavalin A is a type of carbohydrate-binding protein known as a lectin. Ricin is a highly potent toxin. These substances serve various functions in plants, including defense against herbivores and protection from various environmental pathogens.

25. (4) Lecithin
Primary metabolites, such as lecithin, are essential compounds directly involved in the normal growth, development, and reproduction of an organism. Lecithin is a phospholipid crucial for the structure of all cell membranes. In contrast, secondary metabolites like curcumin, morphine, and anthocyanin are not required for basic survival but provide ecological advantages, such as defense mechanisms or attracting pollinators in different plant species.

26. (1) fructose
Inulin is a naturally occurring storage polysaccharide found in many plants, particularly in the roots and tubers of organisms like dahlias. It is a polymer of fructose molecules linked together in a linear chain. Unlike starch or cellulose, which are polymers of glucose, inulin serves as a soluble dietary fiber and is often used in research to measure kidney filtration rates.

27. (1) It does not contain complex helices and hence cannot hold iodine molecules.
The iodine test for polysaccharides depends on the presence of secondary structures. Starch forms a blue-black complex because its helical structure can trap iodine molecules. In contrast, cellulose is a linear, unbranched polymer of glucose that lacks these complex helices. Because it cannot hold iodine within its molecular structure, it does not produce a color change when treated with an iodine solution.

28. (2) Statement I is false but Statement II is true
In protein structure, the sequence is traditionally viewed from left to right, starting with the N-terminal amino acid and ending with the C-terminal amino acid. Therefore, the description of terminals is reversed. However, adult human haemoglobin is correctly characterized as a quaternary protein consisting of four subunits, specifically two alpha chains and two beta chains, which work together for oxygen transport.

29. (1) (p)-(iv), (q)-(i), (r)-(ii), (s)-(iii)
Biological macromolecules are characterized by specific chemical bonds and structures. Proteins consist of amino acids joined by peptide bonds. Unsaturated fatty acids are identified by the presence of one or more carbon-carbon double bonds. Nucleic acids feature a backbone of nucleotides linked by phosphodiester bonds. Polysaccharides are composed of monosaccharide units held together by glycosidic bonds, which are formed through dehydration reactions.

30. (3) Succinic dehydrogenase
Malonate acts as a competitive inhibitor because its molecular structure is very similar to succinate, the natural substrate of succinic dehydrogenase. By binding to the active site of this enzyme, malonate prevents the conversion of succinate to fumarate in the Krebs cycle. This inhibition disrupts cellular respiration in pathogenic bacteria, effectively slowing their

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not made of lipids. They are highly specific in their action and are sensitive to environmental conditions, requiring optimal temperature and pH to function correctly. Exposure to high temperatures typically leads to the denaturation and inactivation of these proteins.

68. (2) D
Basic amino acids are identified by the presence of an additional amino group in their side chain, which provides a net positive charge at physiological pH. Lysine is a classic example of such a basic amino acid, featuring a long hydrocarbon chain ending in an amino group. Structural formulas of amino acids help distinguish them into acidic, basic, or neutral categories based on these specific functional groups.

69. (4) Nucleoside / Uracil
Small molecular weight organic compounds include nucleosides and nucleotides. A nucleoside consists of a nitrogenous base, such as uracil, adenine, or guanine, attached to a pentose sugar without a phosphate group. In chemical diagrams, identifying the absence of a phosphate group helps categorize the molecule as a nucleoside. Uracil is a specific pyrimidine base that is found exclusively in RNA molecules rather than DNA.

70. (1) Lecithin-a phosphorylated glyceride found in cell membrane.
Lecithin is a crucial component of biological membranes and is correctly described as a phosphorylated glyceride, or phospholipid. It contains a glycerol backbone, fatty acids, and a phosphate-linked choline group. Other biomolecules are often mischaracterized; for instance, palmitic acid is a saturated fatty acid with 16 carbons, and adenylic acid is a nucleotide consisting of adenosine and a phosphate group, not a glucose molecule.

71. (3) Collagen
Collagen is a vital structural protein found in the connective tissues of animals, including skin, bones, tendons, and ligaments. It provides essential tensile strength and structural integrity to various organs and tissues. Because it is a fundamental component of the extracellular matrix across the entire animal kingdom, collagen is recognized as the most abundant protein found in animals, surpassing others like haemoglobin or insulin.

72. (4) A : Lecithin - A component of cell membrane
Lecithin is a phospholipid that plays a fundamental role in the structure of cell membranes. It consists of a glycerol backbone esterified to fatty acids and a phosphate group attached to choline. This chemical structure allows it to form the lipid bilayer essential for cellular compartmentalization. Other organic compounds like uracil are components of RNA, while adenine is a nitrogenous base that forms nucleotides and nucleic acids.

73. (2) Temperature / Enzyme activity
The activity of an enzyme is highly dependent on environmental factors like temperature and pH. A graph showing a bell-shaped curve typically represents how enzyme activity changes with these variables. The X-axis represents the condition, such as temperature, while the Y-axis shows the resulting enzyme activity. The peak of the curve indicates the optimum temperature where the enzyme functions most efficiently before denaturing at higher values.

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74. (4) Most enzymes are proteins but some are lipids.
Enzymes are biological catalysts that are predominantly proteins. While some specialized catalytic molecules are made of RNA, known as ribozymes, no enzymes are known to be made of lipids. Enzymes are highly specific to their substrates and require optimal pH and temperature conditions to maintain their three-dimensional structure. High temperatures generally cause proteins to denature, although some thermophilic organisms have enzymes adapted to extreme heat.

75. (2) A-Transition state; B-Potential energy; C-Activation energy without enzyme; D-Activation energy with enzyme
In an enzymatic reaction, the substrate progresses through a high-energy transition state before becoming a product. The graph identifies potential energy on the vertical axis and the reaction progress on the horizontal axis. Activation energy is the energy required to reach the transition state; this barrier is significantly higher without an enzyme. Therefore, the labels correctly identify the transition state, potential energy, and activation energies with and without catalysis.

CHAPTER 10
Cell Cycle and Cell Division

2026 (RE-NEET)

1. Statement I: Chromosomes are fully condensed at the end of prophase I.
Statement II: Meiosis I resembles mitosis. Choose the most appropriate answer:
(1) Statement I is correct, but Statement II is false
(2) Statement I is incorrect, but Statement II is true
(3) Both Statement I and Statement II are true
(4) Both Statement I and Statement II are false

2026 (RE-NEET)

2. The correct sequence of adult cell cycle phases is _ _ _ _ _ _.
(1) G1-S-G2-M
(2) S-M-G2-G1
(3) G1-G2-S-M
(4) G1-M-G2-S

2026 (CANCELLED)

3. Match List I with List II:
List I (Phase of cell cycle):
A. G1 phase
B. S phase
C. G2 phase
D. M phase

List II (Activity):
I. Actual cell division occurs
II. Cell is metabolically active and continuously grows but does not replicate its DNA
III. Synthesis of DNA occurs and the amount of DNA per cell doubles
IV. Proteins are synthesized while cell growth continues
(1) A-IV, B-I, C-II, D-III
(2) A-I, B-II, C-III, D-IV
(3) A-III, B-IV, C-I, D-II
(4) A-II, B-III, C-IV, D-I

2025

4. What is the main function of the spindle fibers during mitosis?
(1) To repair damaged DNA
(2) To regulate cell growth
(3) To separate the chromosomes
(4) To synthesize new DNA

RE-EXAM 2024

5. Match List-I with List-II.

	List-I		List-II
A	Cells are metabolically active and proliferate	I	G_2 phase
B	DNA replication takes place	II	G_1 phase
C	Proteins are synthesised	III	G_0 phase
D	Quiescent stage with metabolically active cells	IV	S phase

Choose the correct answer from the options given below.
(1) A-IV, B-II, C-III, D-I
(2) A-I, B-III, C-IV, D-II
(3) A-II, B-I, C-III, D-IV
(4) A-II, B-IV, C-I, D-III

2024

6. Following are the stages of cell division :
A. Gap 2 phase
B. Cytokinesis
C. Synthesis phase
D. Karyokinesis
E. Gap 1 phase
Choose the correct sequence of stages from the options given below.
(1) C-E-D-A-B
(2) E-B-D-A-C
(3) B-D-E-A-C
(4) E-C-A-D-B

2024

7. Spindle fibers attach to kinetochores of chromosomes during
(1) prophase
(2) metaphase
(3) anaphase
(4) telophase.

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85. (3) Km value
The Michaelis constant, or Km value, is a fundamental parameter in enzyme kinetics that represents the substrate concentration at which the reaction velocity is half of its maximum. It provides an inverse measure of the enzyme's affinity for its substrate. By comparing the Km values of two different enzymes, researchers can evaluate their relative catalytic efficiencies and determine which enzyme binds its substrate more effectively under specific conditions.

86. (2) Competitive inhibition is seen when the substrate and the inhibitor compete for the active site on the enzyme.
Competitive inhibition is a mechanism where an inhibitor molecule, which often structurally resembles the natural substrate, binds to the active site of an enzyme. This prevents the actual substrate from binding, thereby reducing the rate of the reaction. Because this binding is reversible, the inhibition can be overcome by increasing the substrate concentration, which increases the likelihood of the substrate successfully occupying the active site instead of the inhibitor.

87. (1) help in regulating metabolism
Enzymes, vitamins, and hormones are distinct classes of biological chemicals that all play vital roles in the regulation of metabolism. Enzymes act as biological catalysts for chemical reactions, hormones serve as long-distance chemical messengers that signal various physiological changes, and vitamins often function as essential precursors or cofactors for enzymatic activity. Together, they ensure that biochemical pathways operate in a coordinated and efficient manner within living organisms.

88. (4) Tyrosinase
Certain enzymes require specific metal ions as activators or essential components of their active sites to function. Tyrosinase is an enzyme involved in the production of melanin and other pigments, and it specifically requires copper ions for its catalytic activity. The copper ions facilitate the oxidation of phenols, such as tyrosine, which is a critical step in various biosynthetic pathways found in plants, animals, and fungi.

89. (1) co-factors of enzymes
Minor elements, also known as trace elements or micronutrients, are required by living organisms in very small quantities. Despite their low abundance, they play essential roles, primarily by acting as co-factors for various enzymes. These metal ions, such as zinc, iron, and manganese, assist in the catalytic process by stabilizing the enzyme's structure or participating directly in the chemical reactions that occur at the enzyme's active site.

90. (2) hydrophobic
Lipids are a diverse group of organic compounds that are characterized by their insolubility in water and solubility in organic solvents. This property arises because lipid molecules are predominantly hydrophobic, or water-fearing. They consist of long hydrocarbon chains that do not interact favorably with polar water molecules. This hydrophobic nature is essential for the formation of biological membranes, as it allows lipids to create barriers that separate aqueous environments.

NODIA

91. (1) Galactose
Reducing sugars are carbohydrates that possess a free aldehyde or ketone group, enabling them to reduce certain chemical reagents like Fehling's or Benedict's solution. Galactose is a monosaccharide that contains a free aldehyde group in its open-chain form, making it a reducing sugar. In contrast, sucrose is a non-reducing disaccharide because the reactive groups of its glucose and fructose units are involved in the glycosidic bond.

92. (4) Erucic acid
The quality and safety of edible oils can be affected by the presence of certain fatty acids. Erucic acid is a long-chain monounsaturated fatty acid found in oils from the Brassicaceae family, such as rapeseed oil. High levels of erucic acid are associated with the spoilage or contamination of oil and can have adverse health effects. Therefore, monitoring its concentration is a standard method for detecting the spoilage or purity of these oils.

93. (1) phenylalanine
Essential amino acids are those that the body cannot synthesize on its own and therefore must be obtained through the diet. Phenylalanine is one such essential amino acid required for the production of proteins and other important molecules like neurotransmitters. Non-essential amino acids, such as glycine, aspartic acid, and

the specific tissues being measured throughout the body.

111. (4) uracil.
Nucleic acids use a set of four nitrogenous bases to store genetic information. In DNA, these bases are adenine, guanine, cytosine, and thymine. However, in RNA molecules, thymine is not used. Instead, it is replaced by a structurally similar pyrimidine base called uracil. This substitution is one of the key chemical differences between DNA and RNA, along with the type of pentose sugar used in the backbone of the molecule.

112. (1) purine
Nitrogenous bases are the essential components of nucleotides and are divided into two structural categories. Adenine and guanine are classified as purines, which are characterized by a double-ring structure consisting of a six-membered ring fused to a five-membered ring. Cytosine, thymine, and uracil are pyrimidines, which have a single-ring structure. Therefore, adenine is correctly identified as a purine base found in both DNA and RNA molecules in all living organisms.

113. (3) nitrogen base, sugar and phosphate.
A nucleotide is the basic structural unit and building block of nucleic acids like DNA and RNA. It is a composite molecule formed by the combination of three distinct chemical components: a nitrogenous base (either a purine or a pyrimidine), a five-carbon pentose sugar (ribose or deoxyribose), and a phosphate group. These units link together to form long chains that carry the genetic information necessary for the life and reproduction of organisms.

114. (4) deoxyribonucleotides.
Deoxyribonucleic acid, or DNA, is a long polymer made up of repeating monomeric units. Each of these units is a deoxyribonucleotide, which consists of a deoxyribose sugar, a phosphate group, and one of four nitrogenous bases: adenine, guanine, cytosine, or thymine. The sequence of these repeating deoxyribonucleotide units along the DNA strand encodes the genetic instructions used in the development, functioning, and reproduction of all known living organisms and many viruses.

115. (4) nucleotide.
Nucleic acids, such as DNA and RNA, are large biological macromolecules essential for all known forms of life. These polymers are composed of smaller, repeating structural units called nucleotides. Each nucleotide consists of a nitrogenous base, a pentose sugar, and a phosphate group. By linking together through phosphodiester bonds, these basic units form the long chains that store and transmit the genetic information required for cellular processes and the inheritance of traits.

116. (4) 480.
In a double-stranded DNA segment, adenine always pairs with thymine, and cytosine always pairs with guanine, according to Chargaff's rules. This means there are 120 thymine bases and 120 guanine bases to match the given 120 adenines and 120 cytosines. By adding all four types of bases together (120 plus 120 plus 120 plus 120), the total number of nucleotides in the DNA segment is determined to be exactly 480.

117. (2) isoenzymes
Isoenzymes, also known as isozymes, are different molecular forms of the same enzyme that catalyze the exact same chemical reaction. Although they perform identical catalytic activities, they have slightly different amino acid sequences and physical properties, such as different optimal pH or electrophoretic mobility. These variations often allow different tissues or life stages to regulate metabolic pathways more precisely according to their specific physiological needs and environmental conditions within the organism.

118. (3) A + T/C + G is not constant.
The double helical structure of DNA is defined by specific base-pairing rules where adenine equals thymine and cytosine equals guanine. Consequently, the total amount of purines equals the total amount of pyrimidines. While the ratio of (A+T) to (G+C) is constant for a particular species, it varies between different species. Therefore, claiming that this ratio is not constant within a species is inconsistent with the fundamental understanding of DNA's stable molecular structure.

119. (2) thymine
Ribonucleic acid, or RNA, is a single-stranded nucleic acid that plays various roles in coding, decoding, regulation, and expression of genes. Like DNA, it is composed of nucleotides containing a sugar, a phosphate, and a

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stems from the fact that they are polymers made from twenty different amino acids, which can be arranged in an almost infinite variety of sequences and lengths. This allows proteins to fold into unique three-dimensional shapes, enabling them to perform a wide range of functions, including catalysis, structural support, transport, signaling, and immune defense.

103. (4) Glycogren, cellulose and starch
Polysaccharides are complex carbohydrates made up of long chains of monosaccharide units. Glycogen, cellulose, and starch are all examples of polysaccharides composed entirely of glucose monomers, though they differ in their branching patterns and types of glycosidic bonds. In contrast, sucrose, maltose, and lactose are disaccharides consisting of only two sugar units, and glucose and fructose are simple monosaccharides that cannot be broken down further into simpler sugars.

104. (4) Guanine
Nucleic acids contain nitrogenous bases categorized into purines and pyrimidines. The purine bases, characterized by a double-ring structure, are adenine and guanine, both of which are found in both DNA and RNA. Pyrimidine bases include cytosine, which is in both, thymine, which is exclusive to DNA, and uracil, which replaces thymine in RNA. Therefore, guanine is a purine base that is a standard component of RNA molecules.

105. (3) Allosteric inhibition of hexokinase by glucose 6-phosphate
Feedback inhibition is a vital regulatory process where the product of a reaction inhibits the enzyme responsible for its own production. A classic example is the inhibition of the enzyme hexokinase by its product, glucose-6-phosphate. When glucose-6-phosphate accumulates, it binds to an allosteric site on hexokinase, changing the enzyme's shape and reducing its activity. This ensures that the cell does not consume glucose unnecessarily when energy levels are already sufficient.

106. (1) GATCAATGC
The nitrogenous bases in DNA are classified as purines (adenine and guanine) and pyrimidines (cytosine and thymine). In the nucleotide sequence GATCAATGC, the pyrimidine bases are thymine (T) and cytosine (C). Counting these within the sequence reveals two thymines and two cytosines, resulting in a total of four pyrimidine bases. Other provided sequences contain different counts of pyrimidines, such as uracil in RNA-like sequences or different base compositions.

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107. (2) glucose
Glycogen is the primary storage polysaccharide found in animals and fungi, often referred to as animal starch. It is a highly branched homopolymer composed entirely of glucose units. These glucose molecules are linked by alpha-1,4-glycosidic bonds in the linear chains and alpha-1,6-glycosidic bonds at the branching points. This structure allows for the rapid release of glucose into the bloodstream when the body requires energy during physical activity or fasting.

108. (3) Length of one helix is 45 Å in B-DNA.
Nucleic acids have specific structural characteristics that define their function. While DNA is usually double-stranded, it can be single-stranded in some viruses, and RNA can occasionally form double-stranded regions. One complete turn of the B-DNA double helix has a length of 34 Å, not 45 Å. Additionally, Z-DNA is a left-handed helix with 12 base pairs per turn. Therefore, the stated length for the B-DNA helix is incorrect.

109. (4) α-ketoglutaric acid.
Amino acids are synthesized through various metabolic pathways that link nitrogen metabolism with carbohydrate metabolism. A key starting point for the synthesis of several amino acids, particularly glutamate, is alpha-ketoglutaric acid, an intermediate of the citric acid cycle. Through a process called transamination, an amino group is transferred to this organic acid, converting it into an amino acid. This reaction is fundamental for protein biosynthesis and nitrogen assimilation in cells.

110. (4) 65 - 70%.
Water is the most abundant substance in living organisms and is essential for all biological processes. It acts as a solvent, a medium for chemical reactions, and a temperature regulator. In the human body, the average water content typically ranges from 65 to 70 percent of the total body weight. This percentage can vary slightly depending on factors such as age, gender, and

(1) Statement I is correct but Statement II is incorrect.
(2) Statement I is incorrect but Statement II is correct.
(3) Both Statement I and Statement II are correct.
(4) Both Statement I and Statement II are incorrect.

Manipur NEET 2023

16. Doubling of the number of chromosomes can be achieved by disrupting mitotic cell division soon after
(1) anaphase
(2) telophase
(3) prophase
(4) metaphase.

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17. The dissolution of synaptonemal complex occurs during
(1) pachytene (2) diplotene
(3) diakinesis (4) leptotene.

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18. During which stages of mitosis and meiosis respectively does the centromere of each chromosome split?
(1) Metaphase, Metaphase II
(2) Prophase, Telophase I
(3) Telophase, Anaphase I
(4) Anaphase, Anaphase II

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19. Select correct sequence of substages of Prophase-I of meiotic division.
A. Zygotene
B. Pachytene
C. Diakinesis
D. Leptotene
E. Diplotene
Choose the correct answer from the options given below.
(1) (D), (B), (A), (E), (C)
(2) (A), (B), (D), (E), (C)
(3) (D), (A), (B), (E), (C)
(4) (A), (D), (B), (C), (E)

2023

20. The process of appearance of recombination nodules occurs at which sub stage of prophase I in meiosis?
(1) Diplotene (2) Diakinesis
(3) Zygotene (4) Pachytene

2023

21. Which of the following stages of meiosis involves division of centromere?
(1) Anaphase II
(2) Telophase
(3) Metaphase I
(4) Metaphase II

2023

22. Select the correct statements.
A. Tetrad formation is seen during Leptotene.
B. During Anaphase, the centromeres split and chromatids separate.
C. Terminalisation takes place during Pachytene.
D. Nucleolus, Golgi complex and ER are reformed during Telophase.
E. Crossing over takes take between sister chromatids of homologous chromosome.
Choose the correct answer from the options given below:
(1) A, C and E only
(2) B and E only
(3) A and C only
(4) B and D only

2022

23. Which one of the following never occurs during mitotic cell division?
(1) Spindle fibres attach to kinetochores of chromosomes
(2) Movement of centrioles towards opposite poles
(3) Pairing of homologous chromosomes
(4) Coiling and condensation of the chromatids

2022

24. Select the incorrect statement with reference to mitosis.
(1) All the chromosomes lie at the equator at metaphase.
(2) Spindle fibres attach to centromere of chromosomes.
(3) Chromosomes decondense at telophase.
(4) Splitting of centromere occurs at anaphase.

2022

25. The appearance of recombination nodules on homologous chromosomes during meiosis characterises
(1) synaptonemal complex
(2) bivalent
(3) sites at which crossing over occurs
(4) terminalisation.

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nitrogenous base. However, RNA uses the bases adenine, guanine, cytosine, and uracil. It does not possess thymine, which is a pyrimidine base found exclusively in DNA. Instead, uracil serves as the complementary base to adenine in RNA.

120. (1) coiled around a common axis

In the classic Watson-Crick model of DNA, the two polynucleotide strands are arranged in a double helix. These two strands run in opposite directions and are coiled around a central, imaginary common axis. This coiling creates the characteristic spiral ladder shape, where the sugar-phosphate backbones form the outside of the helix and the nitrogenous base pairs, held together by hydrogen bonds, are stacked on the inside, perpendicular to the axis.

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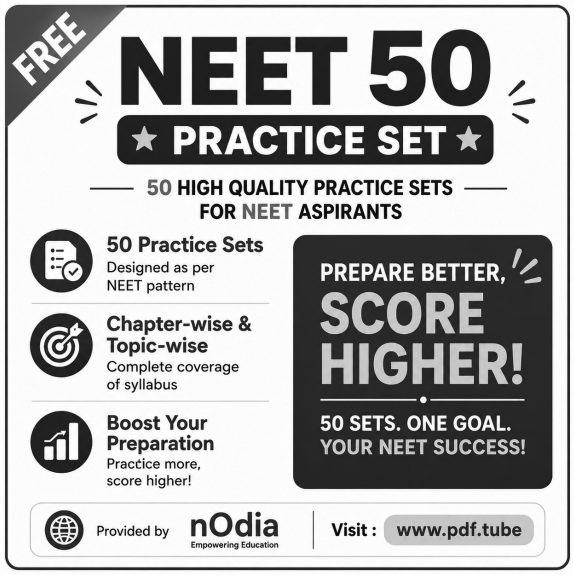

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76. (4) (2) and (4).
Starch is an ideal storage material in plants because of its specific chemical and physical properties. It is chemically non-reactive, meaning it does not easily interfere with other metabolic processes within the cell. Additionally, starch is osmotically inactive because it is insoluble in water. This prevents the storage of large amounts of energy from affecting the osmotic balance and water potential of the plant cell.

77. (3) Pythium
Cellulose is a structural polysaccharide that forms the primary component of plant cell walls. While most fungi have cell walls composed of chitin, certain organisms like Pythium, which belong to the Oomycetes, have cell walls that contain cellulose. This distinguishes them from true fungi and bacteria like Pseudomonas or Xanthomonas, which have cell walls made of peptidoglycan, or yeast like Saccharomyces, which contains glucans and chitin.

78. (3) malonate
Competitive inhibition occurs when a molecule similar in structure to the substrate competes for the enzyme's active site. Malonate is a structural analogue of succinate, which is the natural substrate for the enzyme succinic dehydrogenase in the citric acid cycle. By binding to the active site, malonate prevents succinate from being oxidized to fumarate, thereby inhibiting the enzyme's activity and disrupting cellular energy production.

79. (4) alkaliphiles.
Modern laundry detergents often include enzyme preparations, such as proteases and lipases, to help remove protein and fat-based stains. Because detergent solutions are typically alkaline, these enzymes must be stable and active at high pH levels. Therefore, enzymes derived from alkaliphilic microorganisms, which naturally thrive in basic environments, are used because they maintain their catalytic efficiency under the harsh conditions of a washing cycle.

80. (4) phosphorus and sulphur.
Living organisms are primarily composed of a small set of essential chemical elements. Carbon, hydrogen, nitrogen, and oxygen are the most abundant, forming the backbone of all organic molecules. In addition to these four, phosphorus and sulphur are critical components. Phosphorus is essential for nucleic acids and ATP, while sulphur is a necessary part of certain amino acids like cysteine and methionine, which stabilize protein structures.

81. (2) coenzyme
Coenzymes are non-protein organic substances that bind to enzymes and are essential for their catalytic activity. They often function as intermediate carriers of electrons, specific atoms, or functional groups during biochemical reactions. Unlike prosthetic groups, coenzymes are often loosely associated with the protein part of the enzyme. Without these organic helpers, the apoenzyme remains inactive and cannot facilitate the necessary metabolic transformations within the cell.

82. (3) Glycine
Amino acids are the building blocks of proteins, each having a central carbon atom attached to an amino group, a carboxyl group, and a variable side chain. Glycine is considered the simplest amino acid because its side chain consists of only a single hydrogen atom. This minimal structure makes it the smallest amino acid and allows it to fit into tight spaces within the complex three-dimensional folds of proteins.

83. (1) some bacteria, algae and green plant cells
Carbohydrates are the most abundant biomolecules on Earth and serve as primary energy sources and structural components. They are produced through the process of photosynthesis by autotrophic organisms. This group includes green plant cells, various types of algae, and certain photosynthetic bacteria. These organisms use solar energy to convert carbon dioxide and water into glucose and other complex carbohydrates, forming the foundation of the global food chain.

84. (1) base-sugar-phosphate
Nucleotides are the fundamental monomeric units that link together to form nucleic acids like DNA and RNA. Each individual nucleotide is a complex molecule composed of three distinct parts: a nitrogenous base, a five-carbon pentose sugar, and at least one phosphate group. The sugar and base together form a nucleoside, and the addition of the phosphate group completes the nucleotide structure, enabling it to store genetic information.

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RE-EXAM 2024

8. Match List-I with List-II.

	List-I		List-II
A.	Chiasmata formation	I.	Pachytene
B.	Crossing over	II.	Diakinesis
C.	Synaptonemal complex formation	III.	Diplotene
D.	Terminalisation of chiasmata	IV.	Zygotene

Choose the correct answer from the options given below.
(1) A-III, B-I, C-IV, D-II
(2) A-II, B-I, C-III, D-IV
(3) A-III, B-I, C-II, D-IV
(4) A-II, B-III, C-IV, D-I

RE-EXAM 2024

9. Recombination between homologous chromosomes is completed by the end of
(1) diakinesis
(2) zygotene
(3) diplotene
(4) pachytene.

2024

10. Match List I with List II.

List I (Sub phases of prophase I)			List II (Specific characters)
A.	Diakinesis	I.	Synaptonemal complex formation
B.	Pachytene	II.	Completion of terminalisation of chiasmata
C.	Zygotene	III.	Chromosome look like thin threads
D.	Leptotene	IV.	Appearance of recombination nodules

Choose the correct answer from the options given below.
(1) A-IV, B-II, C-III, D-I
(2) A-I, B-II, C-IV, D-III
(3) A-II, B-IV, C-I, D-III
(4) A-IV, B-III, C-II, D-I

2024

11. Given below are two statements.
Statement I : Chromosomes become visible under light microscope during leptotene stage.
Statement II : The beginning of diplotene stage is recognised by dissolution of synaptonemal complex.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are true.
(2) Both Statement I and Statement II are false.
(3) Statement I is true but Statement II is false.
(4) Statement I is false but Statement II is true.

Manipur NEET 2023

12. Which one of the following is the quiescent stage of cell cycle?
(1) M
(2) G_2
(3) G_1
(4) G_0

2023

13. Match List I with List II.

	List-I		List-II
A.	M Phase	I.	Proteins are synthesized
B.	G_2 Phase	II.	Inactive phase
C.	Quiescent stage	III.	Interval between mitosis and initiation of DNA replication
D.	G_1 Phase	IV.	Equational division

Choose the correct answer from the options given below:
(1) A-IV, B-I, C-II, D-III
(2) A-II, B-IV, C-I, D-III
(3) A-III, B-II, C-IV, D-I
(4) A-IV, B-II, C-I, D-III

2023

14. Among eukaryotes, replication of DNA takes place in -
(1) G_1 phase
(2) G_2 phase
(3) M phase
(4) S phase

2023

15. Given below are two statements:
Statement I : During G_0 phase of cell cycle, the cell is metabolically inactive.
Statement II : The centrosome undergoes duplication during S phase of interphase.
In the light of the above statements, choose the most appropriate answer from the options given below:

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serine, can be produced by the body from other metabolic intermediates, meaning dietary intake is not strictly necessary for survival.

94. (1) Glycoprotein
Conjugated proteins are molecules consisting of a protein part linked to a non-protein component called a prosthetic group. In glycoproteins, the prosthetic group consists of one or more carbohydrate chains. These molecules are essential for various cellular functions, including cell-to-cell recognition and the structure of cell membranes. Other conjugated proteins include lipoproteins, which contain lipids, and nucleoproteins, which are associated with nucleic acids like DNA or RNA.

95. (1) nucleotide
Adenosine triphosphate, commonly known as ATP, is the primary energy currency of the cell. Structurally, it is classified as a nucleotide because it consists of a nitrogenous base (adenine), a pentose sugar (ribose), and three phosphate groups. The energy released from the cleavage of the high-energy phosphate bonds in ATP drives many essential biological processes, including muscle contraction, active transport, and the synthesis of various macromolecules.

96. (1) decrease activation energy
Enzymes are biological catalysts that significantly increase the rate of chemical reactions within cells. They achieve this by providing an alternative reaction pathway with a lower activation energy barrier. By decreasing the energy required for substrates to reach the transition state, enzymes allow reactions to proceed much faster at physiological temperatures, which is essential for maintaining the diverse and complex metabolic processes of life.

97. (3) End product
Feedback inhibition is a regulatory mechanism in which the final product of a metabolic pathway inhibits an enzyme that acts earlier in the sequence. When the concentration of the end product reaches a certain level, it binds to the enzyme, often at an allosteric site, and reduces its activity. This prevents the overproduction of the product and ensures that the cell conserves resources by only producing what is needed.

98. (3) virus
Enzymes are essential for the metabolic processes of all living organisms, including fungi, algae, and cyanobacteria. However, viruses are non-living infectious agents that lack their own cellular machinery and metabolic pathways. While some viruses carry specific enzymes like reverse transcriptase to assist in their replication once inside a host cell, they do not possess the diverse range of enzymes required for independent life and metabolism.

99. (2) unbranched chain of glucose molecules linked by β-1, 4 glycosidic bond
Cellulose is the most abundant organic polymer on Earth and serves as the primary structural component of plant cell walls. It is a homopolysaccharide consisting of long, unbranched chains of D-glucose units. These glucose molecules are linked together by beta-1,4-glycosidic bonds. This specific linkage allows the chains to form straight, rigid fibers that provide the necessary mechanical strength and support to maintain the structural integrity of plants.

100. (1) glucose + galactose
Lactose is a disaccharide commonly known as milk sugar. It is formed through a dehydration synthesis reaction between two different monosaccharide molecules: glucose and galactose. These two sugars are linked by a glycosidic bond. Lactose provides an important source of energy for nursing mammals and is broken down into its constituent monosaccharides by the enzyme lactase in the digestive system to facilitate absorption into the bloodstream.

NODIA

101. (3) accessory non-protein substance attached firmly
A holoenzyme is the complete, active form of an enzyme, consisting of a protein part called the apoenzyme and a non-protein cofactor. Prosthetic groups are a specific type of cofactor that are distinguished by being organic molecules or metal ions that are very tightly or even permanently bound to the apoenzyme. This firm attachment ensures that the enzyme remains functional and ready to catalyze specific biochemical reactions within the cell.

102. (3) Proteins
Proteins are the most diverse and versatile molecules found within a cell. This diversity

2022

26. Regarding meiosis, which of the statements is incorrect?
(1) There are two stages in meiosis, meiosis-I and II.
(2) DNA replication occurs in S phase of meiosis-II.
(3) Pairing of homologous chromosomes and recombination occurs in meiosis-I.
(4) Four haploid cells are formed at the end of meiosis-II.

2021

27. Match List-I with List-II.

	List-I		List-II
(p)	S phase	(i)	Proteins are synthesised
(q)	G2 phase	(ii)	Inactive phase
(r)	Quiescent stage	(iii)	Interval between mitosis and initiation of DNA replication
(s)	G1 phase	(iv)	DNA replication

Select the correct answer from the options given below.
(1) (p)-(ii); (q)-(iv); (r)-(iii); (s)-(i)
(2) (p)-(iii); (q)-(ii); (r)-(i); (s)-(iv)
(3) (p)-(iv); (q)-(ii); (r)-(iii); (s)-(i)
(4) (p)-(iv); (q)-(i); (r)-(ii); (s)-(iii)

2021

28. The fruit fly has 8 chromosomes (2n) in each cell. During interphase of mitosis if the number of chromosomes at G_1 phase is 8, what would be the number of chromosomes after S phase?
(1) 32
(2) 8
(3) 16
(4) 4

2021

29. The centriole undergoes duplication during
(1) G_2 phase
(2) S-phase
(3) prophase
(4) metaphase

2021

30. Which of the following stages of meiosis involves division of centromere ?
(1) Telophase II
(2) Metaphase I
(3) Metaphase II
(4) Anaphase II

2021

31. Which stage of meiotic prophase shows terminalisation of chiasmata as its distinctive feature?
(1) Pachytene
(2) Leptotene
(3) Zygotene
(4) Diakinesis

2020

32. Identify the correct statement with regard to G_1 phase (Gap 1) of interphase.
(1) DNA synthesis or replication takes place.
(2) Reorganisation of all cell components takes place.
(3) Cell is metabolically active, grows but does not replicate its DNA.
(4) Nuclear division takes place.

2020

33. Some dividing cells exit the cell cycle and enter vegetative inactive stage. This is called quiescent stage (G_0). This process occurs at the end of
(1) M phase (2) G_1 phase
(3) S phase (4) G_2 phase.

2020

34. Dissolution of the synaptonemal complex occurs during
(1) pachytene
(2) zygotene
(3) diplotene
(4) leptotene.

2020

35. Match the following with respect to meiosis.

	Column I		Column II
(A)	Zygotene	(i)	Terminalization
(B)	Pachytene	(ii)	Chiasmata
(C)	Diplotene	(iii)	Crossing over
(D)	Diakinesis	(iv)	Synapsis

Select the correct option from the following
(1) (A)- (iii); (B)-(iv); (C)-(i); (D)-(ii)
(2) (A)- (iv); (B)-(iii); (C)-(ii); (D)-(i)
(3) (A)- (i); (B)-(ii); (C)-(iv); (D)-(iii)
(4) (A)- (ii); (B)-(iv); (C)-(iii); (D)-(i)

2019

36. Cells in G_0 phase
(1) terminate the cell cycle
(2) exit the cell cycle
(3) enter the cell cycle
(4) suspend the cell cycle.

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2002

73. Best material for the study of mitosis in laboratory is
(1) anther
(2) root tip
(3) leaf tip
(4) ovary.

2000

74. In which stage of cell cycle, DNA replication occurs?
(1) G_1-phase
(2) S-phase
(3) G_2-phase
(4) M-phase

2000

75. Spindle fibre unite with which structure of chromosomes?
(1) Chromocentre
(2) Chromomere
(3) Kinetochore
(4) Centriole

1998

76. Microtubule is involved in the
(1) muscle contraction
(2) membrane architecture
(3) cell division
(4) DNA recognition.

1997

77. How many mitotic divisions are needed for a single cell to make 128 cells?
(1) 28
(2) 32
(3) 7
(4) 14

1997

78. During cell division in apical meristem, the nuclear membrane appears in
(1) telophase
(2) cytokinesis
(3) metaphase
(4) anaphase.

1997

79. Which of the following structures will not be common to mitotic cell of a higher plant?
(1) Centriole
(2) Spindle fibre
(3) Cell plate
(4) Centromere

1996

80. Which typical stage is known for DNA replication?
(1) S-phase
(2) G_2-phase
(3) metaphase
(4) G_1-phase

1996

81. Colchicine is an inhibitory chemical, which
(1) stops the functioning of centriole
(2) prevents attaching of centromeres with rays
(3) prevents the spindle formation in mitosis
(4) prevents the formation of equatorial plane.

1996

82. When paternal and maternal chromosomes change their materials with each other in cell division this event is called
(1) bivalent-forming
(2) dyad-forming
(3) synapsis
(4) crossing-over.

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1994

83. In a somatic cell cycle, DNA synthesis takes place in
(1) G_1 phase
(2) prophase of mitosis
(3) S phase
(4) G_2 phase.

1994

84. Which of the following represents the best stage to view the shape, size and number of chromosomes?
(1) Prophase (2) Metaphase
(3) Interphase (4) Telophase

1994

85. Which statement best explains the evolutionary advantage of meiosis?
(1) Meiosis is necessary for sexual reproduction.
(2) Genetic recombinations are possible from generation to generation.
(3) Meiosis alternates with mitosis from generation to generation.
(4) The same genetic system is passed on from generation to generation.

1993

86. Meiosis II performs
(1) separation of sex chromosomes
(2) synthesis of DNA and centromere
(3) separation of homologous chromosomes
(4) separation of chromatids.

NEET-I 2016

47. In meiosis crossing over is initiated at
(1) zygotene
(2) diplotene
(3) pachytene
(4) leptotene.

2015 Cancelled

48. A somatic cell that has just completed the S phase of its cell cycle, as compared to gamete of the same species, has
(1) twice the number of chromosomes and four times the amount of DNA
(2) four times the number of chromosomes and twice the amount of DNA
(3) twice the number of chromosomes and twice the amount of DNA
(4) same number of chromosomes but twice the amount of DNA.

2015

49. Arrange the following events of meiosis in correct sequence.
(i) Crossing over
(ii) Synapsis
(iii) Terminalisation of chiasmata
(iv) Disappearance of nucleolus
(1) (i), (ii), (iii), (iv)
(2) (ii), (iii), (iv), (i)
(3) (ii), (i), (iv), (iii)
(4) (ii), (i), (iii), (iv)

2015 Cancelled

50. Select the correct option.

Column I (Processes)		Column II (Stages)	
A.	Synapsis aligns homologous chromosomes	(i)	Zygotene
B.	Synthesis of RNA and protein	(ii)	G2-phase
C.	Action of enzyme recombinase	(iii)	Anaphase I
D.	Centromeres do not separate but chromatids move towards opposite poles	(iv)	Pachytene

(1) A-(i), B-(ii), C-(iv), D-(iii)
(2) A-(ii), B-(iii), C-(iv), D-(v)
(3) A-(i), B-(iii), C-(ii), D-(iv)
(4) A-(i), B-(ii), C-(iv), D-(iii)

2014

51. During which phase(s) of cell cycle, amount of DNA in a cell remains at 4C level if the initial amount is denoted as 2C?
(1) G_0 and G_1
(2) G_1 and S
(3) Only G_2
(4) G_2 and M

2014

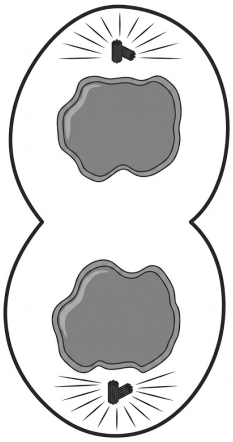
52. In 'S' phase of the cell cycle
(1) amount of DNA doubles in each cell
(2) amount of DNA remains same in each cell
(3) chromosome number is increased
(4) amount of DNA is reduced to half in each cell.

2014

53. The enzyme recombinase is required at which stage of meiosis?
(1) Pachytene
(2) Zygotene
(3) Diplotene
(4) Diakinesis

2013

54. A stage in cell division is shown in the figure. Select the answer which gives correct identification of the stage with its characteristics.



(1) Cytokinesis- Cell plate formed, mitochondria distributed between two daughter cells.
(2) Telophase- Endoplasmic reticulum and nucleolus not reformed yet.
(3) Telophase- Nuclear envelope reforms, Golgi complex reforms.
(4) Late anaphase- Chromosomes move away from equatorial plate, Golgi complex not present.

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2019

37. The correct sequence of phases of cell cycle is
(1) $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$
(2) $M \rightarrow G_1 \rightarrow G_2 \rightarrow S$
(3) $G_1 \rightarrow G_2 \rightarrow S \rightarrow M$
(4) $S \rightarrow G_1 \rightarrow G_2 \rightarrow M$

Odisha NEET 2019

38. Crossing over takes place between which chromatids and in which stage of the cell cycle ?
(1) Non-sister chromatids of non-homologous chromosomes at Zygotene stage of prophase I.
(2) Non-sister chromatids of homologous chromosomes at Pachytene stage of prophase I.
(3) Non-sister chromatids of homologous chromosomes at Zygotene stage of prophase I.
(4) Non-sister chromatids of non-homologous chromosomes at Pachytene stage of prophase I.

2018

39. The stage during which separation of the paired homologous chromosomes begins is
(1) pachytene (2) diplotene
(3) diakinesis (4) zygotene.

2017

40. Which of the following options gives the correct sequence of events during mitosis ?
(1) Condensation → Nuclear membrane disassembly → Arrangement at equator → Centromere division → Segregation → Telophase
(2) Condensation → Crossing over → Nuclear membrane disassembly → Segregation → Telophase
(3) Condensation → Arrangement at equator → Centromere division → Segregation → Telophase
(4) Condensation → Nuclear membrane disassembly → Crossing over → Segregation → Telophase

2017

41. Anaphase Promoting Complex (APC) is a protein degradation machinery necessary for proper mitosis of animal cell. If APC is defective in a human cell, which of the following is expected to occur?
(1) Chromosomes will be fragmented.
(2) Chromosomes will not segregate.
(3) Recombination of chromosome arms will occur.
(4) Chromosomes will not condense.

NEET-II 2016

42. During cell growth, DNA synthesis takes place on
(1) S-phase (2) G_1-phase
(3) G_2-phase (4) M phase.

NEET-II 2016

43. When cell has stalled DNA replication fork, which checkpoint should be predominantly activated?
(1) G_1/S
(2) G_2/M
(3) M
(4) Both G_2/M and M

NEET-I 2016

44. Spindle fibres attach on to
(1) centromere of the chromosome
(2) kinetosome of the chromosome
(3) telomere of the chromosome
(4) kinetochore of the chromosome.

NEET-I 2016

45. Which of the following is not a characteristic feature during mitosis in somatic cells?
(1) Chromosome movement
(2) Synapsis
(3) Spindle fibres
(4) Disappearance of nucleolus

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NEET-II 2016

46. Match the stages of meiosis in column I to their characteristic features in column II and select the correct option using the codes given below.

	Column I (Stages)		Column II (Feature)
A.	Pachytene	(i)	Pairing of homologous chromosomes
B.	Metaphase I	(ii)	Terminalisation of chiasmata
C.	Diakinesis	(iii)	Crossing-over takes place
D.	Zygotene	(iv)	Chromosomes align at equatorial plate

(1) A-(iii), B-(iv), C-(ii), D-(i)
(2) A-(i), B-(iv), C-(ii), D-(iii)
(3) A-(ii), B-(iv), C-(iii), D-(i)
(4) A-(iv), B-(iii), C-(ii), D-(i)

Mains 2011

63. At metaphase, chromosomes are attached to the spindle fibres by their
(1) satellites
(2) secondary constrictions
(3) kinetochores
(4) centromeres.

2010

64. During mitosis, ER and nucleolus begin to disappear at
(1) late prophase
(2) early metaphase
(3) late metaphase
(4) early prophase.

2010

65. Which stages of cell division do the following figures A and B represent respectively?

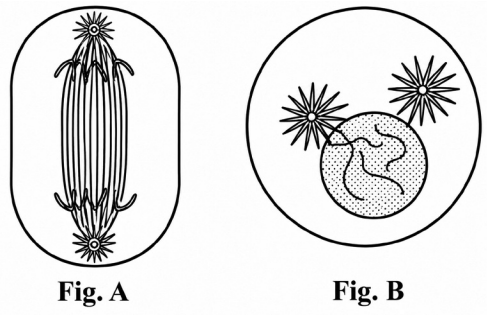
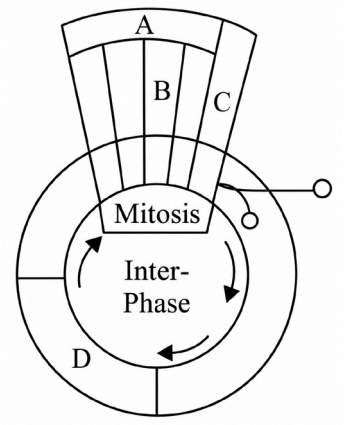


Fig. A Fig. B

	A	B
(1)	Metaphase	Telophase
(2)	Telophase	Metaphase
(3)	Late anaphase	Prophase
(4)	Prophase	Anaphase

2009

66. Given below is a schematic break-up of the phases/stages of cell cycle. Which one of the following is the correct indication of the stage/ phase in the cell cycle?



(1) C - karyokinesis
(2) D - synthetic phase
(3) A - cytokinesis
(4) B - metaphase

2009

67. Synapsis occurs between
(1) mRNA and ribosomes
(2) spindle fibres and centromere
(3) two homologous chromosomes
(4) a male and a female gamete.

2005

68. At what stage of the cell cycle are histone proteins synthesised in a eukaryotic cell?
(1) During G_2 stage of prophase
(2) During S-phase
(3) During entire prophase
(4) During telophase

2004

69. In the somatic cell cycle
(1) in G_1 phase DNA content is double the amount of DNA present in the original cell
(2) DNA replication takes place in S phase
(3) a short interphase is followed by a long mitotic phase
(4) G_2 phase follows mitotic phase.

2004

70. If you are provided with root-tips of onion in your class and are asked to count the chromosomes, which of the following stages can you most conveniently look into?
(1) Metaphase (2) Telophase
(3) Anaphase (4) Prophase

2004

71. Which one of the following precedes reformation of the nuclear envelope during M phase of the cell cycle?
(1) Decondensation from chromosomes and reassembly of the nuclear lamina
(2) Transcription from chromosomes and reassembly of the nuclear lamina
(3) Formation of the contractile ring and formation of the phragmoplast
(4) Formation of the contractile ring and transcription from chromosomes

2002

72. Mitotic spindle is mainly composed of which protein?
(1) Actin (2) Tubulin
(3) Actomyosin (4) Myoglobin

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ANSWERS

1. (1) Statement I is correct, but Statement II is false
Chromosomes become fully condensed by the end of prophase I, so Statement I is correct. Meiosis I separates homologous chromosomes and is reductional, unlike mitosis which is equational. It is meiosis II that resembles mitosis, so Statement II is false.

2. (1) G1-S-G2-M
The cell cycle proceeds through interphase, comprising G1 (growth), S (DNA synthesis) and G2 (preparation for division), followed by the M phase (mitosis). Therefore the correct sequence is G1-S-G2-M.

3. (4) A-II, B-III, C-IV, D-I
In G1 phase the cell grows and is metabolically active but DNA is not replicated. In S phase DNA synthesis occurs and DNA content doubles. In G2 phase proteins are synthesised and growth continues. In M phase actual cell division (mitosis) takes place.

4. (3) To separate the chromosomes
Spindle fibers are microscopic protein structures that help divide genetic material during cell division. Composed primarily of microtubules, they emerge from centrosomes and attach to the kinetochores of chromosomes. Their primary role is to pull sister chromatids or homologous chromosomes toward opposite poles, ensuring each daughter cell receives the correct number of chromosomes.

5. (4) A-II, B-IV, C-I, D-III
The cell cycle consists of distinct stages where specific metabolic events occur to prepare for division. In the G_1 phase, cells are metabolically active and grow. DNA replication is restricted to the S phase. Proteins necessary for mitosis are synthesized during G_2. Finally, the G_0 phase represents a quiescent stage where cells remain active but no longer proliferate.

6. (4) E-C-A-D-B
The cell cycle follows a strictly regulated chronological order to ensure accurate genetic inheritance. It begins with the Gap 1 phase for growth, followed by the Synthesis phase for DNA replication. After the Gap 2 phase prepares the cell further, karyokinesis involves the division of the nucleus. The process concludes with cytokinesis, which physically divides the cytoplasm.

7. (2) metaphase
Metaphase is a crucial stage of mitosis characterized by the alignment of chromosomes along the cell's equatorial plane. During this phase, spindle fibers originating from opposite poles attach to the kinetochores of sister chromatids. This attachment is essential for the subsequent equal distribution of genetic material as the cell prepares to pull the chromatids toward opposite poles.

8. (1) A-III, B-I, C-IV, D-II
Prophase I of meiosis involves complex chromosomal interactions. Synapsis and the formation of the synaptonemal complex occur during the zygotene stage. Crossing over between non-sister chromatids happens in pachytene. The diplotene stage is marked by the appearance of chiasmata as the complex dissolves. Finally, diakinesis involves the terminalisation of these chiasmata, preparing chromosomes for separation.

9. (4) pachytene.
Recombination is the process where genetic material is exchanged between non-sister chromatids of homologous chromosomes. This event occurs during the pachytene stage of prophase I in meiosis. By the end of this stage, the exchange of DNA segments is completed, leaving the chromosomes linked at the sites of crossing over, which are later visible as chiasmata.

10. (3) A-II, B-IV, C-I, D-III
Prophase I is divided into five specific sub-stages based on chromosomal behavior. During leptotene, chromosomes appear as thin threads. Zygotene involves the formation of the synaptonemal complex. Pachytene is characterized by the appearance of recombination nodules where crossing over occurs. Diakinesis marks the end of prophase I, characterized by

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1992

87. Number of chromatids at metaphase is
(1) two each in mitosis and meiosis
(2) two in mitosis and one in meiosis
(3) two in mitosis and four in meiosis
(4) one in mitosis and two in meiosis.

1991

88. Mitotic anaphase differs from metaphase in possessing
(1) same number of chromosomes and same number of chromatids
(2) half number of chromosomes and half number of chromatids
(3) half number of chromosomes and same number of chromatids
(4) same number of chromosomes and half number of chromatids.

1991

89. In meiosis, the daughter cells differ from parent cell as well as amongst themselves due to
(1) segregation, independent assortment and crossing over
(2) segregation and crossing over
(3) independent assortment and crossing over
(4) segregation and independent assortment.

1988

90. Meiosis I is reductional division. Meiosis II is equational division due to
(1) pairing of homologous chromosomes
(2) crossing over
(3) separation of chromatids
(4) disjunction of homologous chromosomes.

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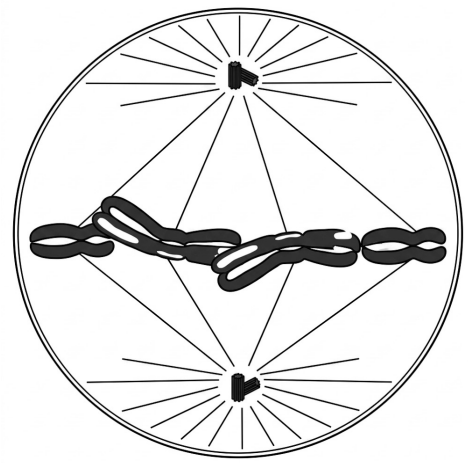
Karnataka NEET 2013

55. During the metaphase stage of mitosis, spindle fibres attach to chromosomes at
(1) kinetochore
(2) both centromere and kinetochore
(3) centromere, kinetochore and areas adjoining centromere
(4) centromere.

Karnataka NEET 2013

56. A stage of mitosis is shown in the diagram. Which stage is it and what are its characteristics?



(1) Metaphase - Spindle fibers attached to kinetochores, centromeres split and chromatids separate.
(2) Metaphase - Chromosomes moved to spindle equator, chromosomes made up of two sister chromatids.
(3) Anaphase - Centromeres split and chromatids separate and start moving away.
(4) Late prophase - Chromosomes move to spindle equator.

2013

57. The complex formed by a pair of synapsed homologous chromosomes is called
(1) bivalent
(2) axoneme
(3) equatorial plate
(4) kinetochore.

Karnataka NEET 2013

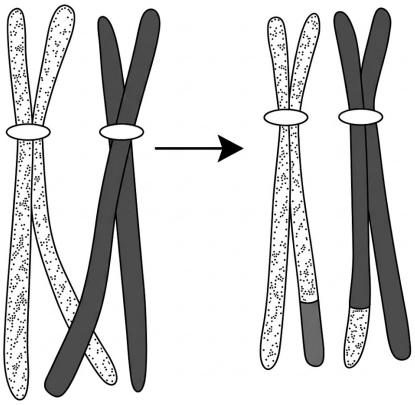
58. During meiosis I, the chromosomes start pairing at
(1) zygotene
(2) pachytene
(3) diplotene
(4) leptotene.

2012

59. During gamete formation, the enzyme recombinase participates during
(1) metaphase I
(2) anaphase II
(3) prophase I
(4) prophase II.

2012

60. The given figure is the representation of a certain event at a particular stage of a type of cell division. Which is this stage?



(1) Prophase I during meiosis
(2) Prophase II during meiosis
(3) Prophase of mitosis
(4) Both prophase and metaphase of mitosis

Mains 2012

61. Identify the meiotic stage in which the homologous chromosomes separate while the sister chromatids remain associated at their centromeres.
(1) Metaphase I
(2) Metaphase II
(3) Anaphase I
(4) Anaphase II

2011

62. Select the correct option with respect to mitosis.
(1) Chromatids separate but remain in the centre of the cell in anaphase.
(2) Chromatids start moving towards opposite poles in telophase.
(3) Golgi complex and endoplasmic reticulum are still visible at the end of prophase.
(4) Chromosomes move to the spindle equator and get aligned along equatorial plate in metaphase.

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the complete terminalisation of chiasmata and nuclear envelope breakdown.

11. (1) Both Statement I and Statement II are true.
During the first stage of prophase I, known as leptotene, chromatin fibers condense, making chromosomes visible under a light microscope. As the process moves into the diplotene stage, the synaptonemal complex, which held homologous chromosomes together, begins to dissolve. This dissolution allows the paired chromosomes to separate slightly, except at the specific sites where crossing over occurred.

12. (4) G_0
Some cells in adult animals do not appear to exhibit division and only divide as needed to replace lost cells. These cells exit the G_1 phase to enter an inactive stage called the quiescent stage or G_0 phase. While cells in this stage are metabolically active, they no longer undergo proliferation unless they are called to do so.

13. (1) A-IV, B-I, C-II, D-III
The cell cycle includes the M phase, where equational division occurs to produce daughter cells. The G_2 phase is dedicated to protein synthesis in preparation for mitosis. The quiescent stage, or G_0, is an inactive phase regarding cell proliferation. G_1 represents the interval following mitosis and preceding the initiation of DNA replication, focusing on cell growth and metabolism.

14. (4) S phase
In eukaryotic organisms, the cell cycle is divided into interphase and the mitotic phase. The S phase, or synthesis phase, is the specific period during interphase when DNA replication occurs. During this time, the amount of DNA per cell doubles, although the chromosome number remains the same, ensuring that each daughter cell will receive a full genetic complement.

15. (2) Statement I is incorrect but Statement II is correct.
Cells entering the G_0 phase exit the cell cycle and remain metabolically active, despite no longer proliferating. Therefore, describing them as metabolically inactive is inaccurate. Conversely, the duplication of the centrosome is a vital event that occurs in the cytoplasm during the S phase. This process happens simultaneously with DNA replication in the nucleus to prepare for spindle formation.

16. (1) anaphase
Doubling the number of chromosomes in a cell can be achieved by preventing the completion of mitosis after certain stages. During anaphase, sister chromatids separate and move toward opposite poles. If the cell division process is disrupted immediately after this separation and before the cell physically divides during cytokinesis, the resulting single cell will contain twice the original chromosome count.

17. (2) diplotene
The synaptonemal complex is a protein structure that forms between homologous chromosomes during the zygotene stage of prophase I. Its primary function is to facilitate synapsis and crossing over. The beginning of the diplotene stage is recognized by the dissolution of this complex, which allows the homologous chromosomes to move apart while remaining joined at chiasmata.

18. (4) Anaphase, Anaphase II
In mitosis, the splitting of the centromere occurs during anaphase, allowing sister chromatids to separate and move to opposite poles. In meiosis, this specific event is delayed until the second division. During anaphase II, the centromeres of each chromosome finally split, enabling the sister chromatids to move toward the poles, resulting in the formation of haploid daughter cells.

19. (3) (D), (A), (B), (E), (C)
Meiosis I begins with prophase I, which is significantly longer and more complex than mitotic prophase. It is subdivided into five distinct stages based on chromosomal behavior. The correct chronological sequence starts with leptotene, followed by zygotene and pachytene. The final two stages are diplotene and diakinesis. This sequence ensures proper pairing, crossing over, and preparation for segregation.

20. (4) Pachytene
The pachytene stage of prophase I is characterized by the appearance of recombination nodules. These nodules represent the sites where crossing over occurs between non-sister chromatids of homologous chromosomes. This process is mediated by the enzyme recombinase and leads to the exchange of genetic material, which is

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a fundamental source of genetic variation in sexually reproducing organisms.

21. (1) Anaphase II
Meiosis consists of two successive divisions. During meiosis I, homologous chromosomes separate, but the sister chromatids remain attached at their centromeres. The actual division of the centromere occurs during anaphase II of the second meiotic division. This event allows the sister chromatids to finally separate and migrate to opposite poles, ensuring the production of four haploid cells.

22. (4) B and D only
During anaphase, centromeres split, allowing sister chromatids to separate and move toward opposite poles. At the end of the mitotic process, telophase occurs, during which the nucleolus, Golgi complex, and endoplasmic reticulum are reformed. Other events, like tetrad formation, occur during zygotene rather than leptotene, and crossing over involves non-sister chromatids, making specific observations essential for accuracy.

23. (3) Pairing of homologous chromosomes
Mitosis is an equational division that preserves the chromosome number in daughter cells. While it involves spindle fiber attachment to kinetochores and the movement of centrioles, it does not involve the pairing of homologous chromosomes. Synapsis or pairing is a unique feature of meiosis I, specifically during the zygotene stage, and is absent in all stages of mitotic division.

24. (2) Spindle fibres attach to centromere of chromosomes.
During mitosis, chromosomes align at the equator during metaphase, and their centromeres split during anaphase to allow chromatid separation. At telophase, chromosomes reach the poles and decondense. However, it is important to note that spindle fibers do not attach directly to the centromere itself; instead, they attach to specialized protein structures called kinetochores located on the centromeres.

25. (3) sites at which crossing over occurs
In the pachytene stage of meiotic prophase I, large protein complexes known as recombination nodules appear on the synaptonemal complex. These nodules serve as the specific sites where crossing over, or the exchange of genetic material between non-sister chromatids of homologous chromosomes, takes place. Their presence is a hallmark of the recombination process mediated by the enzyme recombinase.

26. (2) DNA replication occurs in S phase of meiosis-II.
Meiosis involves a single round of DNA replication followed by two nuclear divisions. This replication occurs during the S phase of interphase before meiosis I begins. There is no DNA replication during the interkinesis period or the S phase of meiosis II. Consequently, the cells enter the second meiotic division with the same amount of DNA they had after meiosis I.

27. (4) (iv), (i), (ii), (iii)
The phases of the cell cycle are defined by specific biochemical activities. The S phase is the period dedicated to DNA replication. During the G_2 phase, the cell synthesizes proteins required for division. The quiescent stage, or G_0, represents an inactive phase where cells stop proliferating. G_1 phase occurs as the interval between mitosis and the start of DNA replication.

28. (2) 8
The S phase is characterized by DNA synthesis, where the amount of DNA in the cell doubles. However, the chromosome number remains unchanged during this period. If a cell begins with 8 chromosomes in the G_1 phase, it will still contain exactly 8 chromosomes after the S phase is complete, even though each chromosome now consists of two sister chromatids.

29. (2) S-phase
During the cell cycle, specific organelles and genetic materials must be duplicated to ensure successful division. While DNA replication takes place within the nucleus during the S phase, the centrioles also undergo duplication in the cytoplasm at the same time. This ensures that two pairs of centrioles are available to form the opposite poles of the mitotic spindle.

30. (4) Anaphase II
In the process of meiosis, the division of centromeres is a late event. During anaphase I, homologous chromosomes are separated, but their sister chromatids remain joined. It is only during anaphase II that the centromere of each chromosome finally splits. This allows

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the sister chromatids to move toward opposite poles, resulting in the formation of individual chromosomes for the gametes.

31. (4) Diakinesis
Prophase I of meiosis concludes with the stage known as diakinesis. This phase is primarily identified by the terminalisation of chiasmata, which are the X-shaped structures representing the sites of previous crossing over. During this stage, chromosomes are fully condensed, the meiotic spindle is assembled, and the nucleolus and nuclear envelope disappear, transitioning the cell into metaphase I.

32. (3) Cell is metabolically active, grows but does not replicate its DNA.
The G_1 phase, or Gap 1, is the first stage of interphase following the M phase. During this time, the cell is highly metabolically active and undergoes continuous growth as it prepares for the next stages. Importantly, while the cell increases its size and synthesizes necessary proteins and organelles, it does not replicate its DNA until it enters the subsequent S phase.

33. (2) G_1 phase
In multicellular organisms, some cells do not divide continuously. These cells exit the cell cycle and enter a non-proliferating, vegetative state known as the G_0 or quiescent stage. This transition occurs when cells that do not divide further exit the G_1 phase to enter an inactive stage called the quiescent stage or G_0 phase.

34. (3) diplotene.
The synaptonemal complex is a proteinaceous structure that mediates the pairing of homologous chromosomes. Its dissolution signals the start of the diplotene stage in prophase I of meiosis. As the complex breaks down, the paired homologous chromosomes begin to separate from each other, although they remain attached at the sites where crossing over took place, known as chiasmata.

35. (2) (iv), (iii), (ii), (i)
The sub-stages of prophase I are defined by specific chromosomal events. Zygotene involves synapsis, the pairing of homologous chromosomes. Pachytene is marked by crossing over, the exchange of genetic material. Diplotene is characterized by the visibility of chiasmata following the dissolution of the synaptonemal complex. Finally, diakinesis is the stage where the terminalization of these chiasmata occurs before the spindle fibers attach.

36. (2) exit the cell cycle
Cells in the G_0 phase have essentially exited the active cell cycle. These cells do not continue through the G_1, S, G_2, and M phases. While they remain metabolically active and can perform their specific physiological functions, they have stopped dividing. Some cells remain in this stage permanently, while others can be stimulated to re-enter the cycle under specific conditions.

37. (1) $G_1 \rightarrow S \rightarrow G_2 \rightarrow M$
The cell cycle is an orderly sequence of events divided into interphase and the M phase. Interphase consists of three distinct parts: the G_1 phase for growth, the S phase for DNA replication, and the G_2 phase for final preparations and protein synthesis. Once interphase is complete, the cell enters the M phase, which includes both nuclear and cytoplasmic division.

38. (2) Non-sister chromatids of homologous chromosomes at Pachytene stage of prophase I.
Crossing over is a vital genetic process that occurs during the pachytene stage of prophase I in meiosis. It involves the physical exchange of genetic segments between the non-sister chromatids of a homologous chromosome pair. This exchange is facilitated by the formation of recombination nodules and the action of the enzyme recombinase, leading to new genetic combinations in offspring.

39. (2) diplotene
The diplotene stage of prophase I marks the beginning of the separation of paired homologous chromosomes. This occurs because the synaptonemal complex, which held the chromosomes together during synapsis and crossing over, begins to dissolve. Despite this separation, the homologous chromosomes remain connected at specific X-shaped points called chiasmata, where the exchange of genetic material previously occurred.

40. (1) Condensation → Nuclear membrane disassembly → Arrangement at equator → Centromere division → Segregation → Telophase
Mitosis begins with prophase, where chromosomes condense and the nuclear membrane breaks down. During metaphase, chromosomes arrange themselves at the cell's equator. Anaphase

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60. (1) Prophase I during meiosis.
Prophase I is a prolonged and specialized stage of meiosis characterized by unique chromosomal activities not seen in mitosis. These activities include the pairing of homologous chromosomes (synapsis) and the exchange of genetic material (crossing over). Such events are exclusive to the first meiotic division and are vital for increasing genetic diversity through the reshuffling of maternal and paternal genes.

61. (3) Anaphase I
Anaphase I of meiosis is the stage where homologous chromosomes move toward opposite poles of the cell. Unlike in mitosis or anaphase II, the sister chromatids do not separate during this stage; they remain attached at their common centromere. This process effectively reduces the chromosome number by half, which is the defining characteristic of the first meiotic division.

62. (4) Chromosomes move to the spindle equator and get aligned along equatorial plate in metaphase.
In mitosis, the metaphase stage is characterized by the migration of chromosomes to the cell's center. They align themselves along the equatorial plate, also known as the metaphase plate. During this phase, spindle fibers from opposite poles connect to the kinetochores of sister chromatids. This alignment is a prerequisite for the subsequent equal separation of genetic material during anaphase.

63. (3) kinetochores.
During the metaphase of cell division, the chromosomes are highly condensed and clearly visible. They are held in position at the equatorial plate by spindle fibers. These fibers attach to the kinetochores, which are specialized protein complexes found on the centromere of each chromosome. This connection allows the spindle apparatus to exert the force needed to move and eventually separate the chromatids.

64. (4) early prophase.
Prophase is the first stage of mitosis and is marked by significant structural changes within the cell. As the chromosomes begin to condense and the mitotic spindle starts to form, several cellular organelles undergo transformation. Specifically, the nucleolus and the endoplasmic reticulum are no longer visible by the end of this phase, allowing the cytoplasm to accommodate the machinery needed for chromosomal segregation.

65. (3) Late anaphase Prophase
Cell division stages are identified by the position and state of the chromosomes. Late anaphase is characterized by chromatids that have nearly reached the opposite poles of the cell and have begun to cluster. In contrast, prophase is identified by the initial condensation of chromatin into visible chromosomes and the beginning of the breakdown of the nuclear envelope and other organelles.

66. (2) D - synthetic phase.
The cell cycle is divided into interphase and the M phase. Interphase consists of the G_1, S, and G_2 stages. In many schematic diagrams, these stages are labeled sequentially. The S phase, or synthetic phase, is the period during which DNA replication occurs. It follows the G_1 phase and precedes G_2, ensuring that the cell's genetic material is duplicated before nuclear division.

67. (3) two homologous chromosomes.
Synapsis is a fundamental event that occurs during the zygotene stage of prophase I in meiosis. It involves the side-by-side pairing of two homologous chromosomes, which are chromosomes that carry the same genes in the same order but may have different alleles. This close association is necessary for the subsequent exchange of genetic material through crossing over in the pachytene stage.

68. (2) During S-phase
Histone proteins are essential for the structural organization of eukaryotic chromosomes, as they provide the spool around which DNA is wound to form nucleosomes. Since DNA replication occurs during the S phase of the cell cycle, histone synthesis must also occur at the same time. This ensures that the newly synthesized DNA can be immediately packaged into chromatin.

69. (2) DNA replication takes place in S phase.
The somatic cell cycle is the process by which a cell duplicates its contents and divides into two. It consists of a long interphase followed by a relatively short M phase. A key event during interphase is the S phase, or synthesis phase, during which the cell's DNA is replicated to ensure that both daughter cells receive a complete genome.

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zygotene, while pachytene involves the action of the recombinase enzyme for crossing over. In the G_2 phase, the cell focuses on synthesizing RNA and proteins. During anaphase I of meiosis, homologous chromosomes move to opposite poles while their sister chromatids remain attached, meaning the centromeres do not yet separate.

51. (4) G_2 and M
If a cell starts the G_1 phase with a DNA amount of 2C, this amount doubles to 4C during the S phase when replication occurs. Therefore, throughout the subsequent G_2 phase and the early stages of the M phase until the cell physically divides, the DNA content remains at the 4C level. It only returns to 2C after cytokinesis is completed in mitosis.

52. (1) amount of DNA doubles in each cell
The S phase, or synthesis phase, is the specific period in the cell cycle dedicated to the replication of nuclear DNA. During this stage, the quantity of DNA within the cell is exactly doubled. However, it is important to understand that the number of chromosomes does not increase; each chromosome simply consists of two identical sister chromatids instead of one.

53. (1) Pachytene
Recombinase is a specialized enzyme required for the process of genetic recombination during meiosis. This enzyme facilitates the breaking and rejoining of DNA strands between non-sister chromatids of homologous chromosomes. This activity occurs during the pachytene stage of prophase I, where it mediates the exchange of genetic material at the recombination nodules, contributing to genetic variation in species.

54. (3) Telophase Nuclear envelope reforms, Golgi complex reforms.
Telophase is the final stage of karyokinesis in cell division. During this phase, the chromosomes that have reached their respective poles begin to decondense and lose their individuality. The nuclear envelope assembles around each set of chromosomes, and other cellular components, such as the nucleolus, Golgi complex, and endoplasmic reticulum, are also reformed, preparing the two new nuclei for cytokinesis.

55. (1) kinetochore
In the metaphase of mitosis, chromosomes must be positioned at the cell's center for even distribution. This is achieved by spindle fibers that extend from the centrosomes. These fibers attach specifically to the kinetochore, a disc-shaped protein structure located on the centromere of each chromatid. This attachment is critical for pulling the sister chromatids apart in the following anaphase stage.

56. (2) Metaphase - Chromosomes moved to spindle equator, chromosomes made up of two sister chromatids.
Metaphase is easily identified by the alignment of chromosomes along the equatorial plate of the cell. At this stage, each chromosome is composed of two identical sister chromatids held together by a centromere. The spindle fibers from opposite poles are attached to the kinetochores of these chromatids, ensuring they are positioned correctly before being pulled toward the opposite ends of the cell.

57. (1) bivalent
During the zygotene stage of prophase I in meiosis, homologous chromosomes undergo a pairing process known as synapsis. The resulting structure, formed by the close association of two homologous chromosomes, is called a bivalent. Since each chromosome in the pair consists of two chromatids, this complex is also sometimes referred to as a tetrad when all four chromatids are visible.

58. (1) zygotene
The first division of meiosis begins with a complex prophase I. The second sub-stage of this phase is zygotene. During zygotene, homologous chromosomes begin to pair together in a process called synapsis. This pairing is highly specific and is accompanied by the formation of a protein structure called the synaptonemal complex, which stabilizes the interaction between the paired chromosomes.

59. (3) prophase I.
The enzyme recombinase is essential for the process of crossing over, which allows for the exchange of genetic material between homologous chromosomes. This event occurs during the first division of meiosis, specifically during the pachytene sub-stage of prophase I. By facilitating the breakage and reunion of DNA strands, the enzyme ensures that the resulting gametes possess unique genetic combinations.

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follows, involving the division of centromeres and the segregation of sister chromatids to opposite poles. Finally, telophase occurs as chromosomes decondense and new nuclear envelopes form, leading to the completion of the division process.

41. (2) Chromosomes will not segregate.
The Anaphase Promoting Complex (APC) is a critical protein degradation system that triggers the transition from metaphase to anaphase. It targets specific proteins, such as securin, for destruction, which allows the enzyme separase to break down the cohesin holding sister chromatids together. If APC is defective, chromatids cannot separate, preventing the proper segregation of chromosomes to daughter cells.

42. (1) S-phase
DNA synthesis, or replication, is a fundamental process that ensures each daughter cell receives a complete set of genetic instructions. This replication takes place exclusively during the S phase, or synthesis phase, of the cell cycle's interphase. During this interval, the nuclear DNA content is doubled, providing the necessary material for the subsequent division of the nucleus.

43. (2) G_2/M
Cell cycle checkpoints serve as control mechanisms that monitor and verify whether the processes at each phase have been accurately completed. If DNA replication is stalled or incomplete during the S phase, the cell must stop before entering the M phase. The G_2/M checkpoint is responsible for detecting such issues, preventing the cell from initiating mitosis until DNA replication is fully finished.

44. (4) kinetochore of the chromosome.
During cell division, chromosomes must be accurately moved and partitioned. This movement is facilitated by spindle fibers, which are microtubule structures. These fibers do not attach to the entire centromere but specifically bind to the kinetochore. The kinetochore is a complex protein structure assembled on the centromeric region of each sister chromatid, serving as the physical attachment point for the spindle.

45. (2) Synapsis
Mitosis is characterized by the condensation of chromosomes, the formation of spindle fibers, and the eventual disappearance of the nucleolus as the cell prepares to divide. However, synapsis, which is the pairing of homologous chromosomes, is not a feature of mitosis. Synapsis occurs exclusively during the zygotene stage of prophase I in meiosis to facilitate crossing over and genetic recombination.

46. (1) A-(iii), B-(iv), C-(ii), D-(i)
Prophase I stages and Metaphase I are defined by specific events. Zygotene is the stage where homologous chromosomes pair up, a process called synapsis. Pachytene follows, where crossing over occurs between these pairs. During Metaphase I, the bivalents align at the equatorial plate. Finally, diakinesis is marked by the terminalisation of chiasmata, signaling the end of the first meiotic prophase.

47. (3) pachytene.
Crossing over is the process where genetic material is exchanged between non-sister chromatids of homologous chromosomes. This complex event is initiated during the pachytene stage of prophase I in meiosis. It occurs at specific sites called recombination nodules and is facilitated by the enzyme recombinase. This process is essential for generating genetic diversity in the offspring of sexually reproducing organisms.

NODIA

48. (1) twice the number of chromosomes and four times the amount of DNA
A gamete is haploid (n) and has a base amount of DNA (1C). A normal somatic cell is diploid (2n) with 2C DNA. After the S phase, a somatic cell has duplicated its DNA but not its chromosome number; thus, it remains 2n but has 4C DNA. Comparing this to a gamete (n, 1C), the cell has twice the chromosomes and four times the DNA.

49. (4) (ii), (i), (iii), (iv)
The early stages of meiosis follow a precise chronological order to ensure correct genetic recombination. The process begins with synapsis during zygotene, where homologous chromosomes pair. This is followed by crossing over in pachytene. Later, in diplotene and diakinesis, the terminalisation of chiasmata occurs. Finally, the prophase concludes with the disappearance of the nucleolus as the cell enters metaphase.

50. (4) A-(i), B-(ii), C-(iv), D-(iii)
Chromosomal behavior varies across different stages of division. Synapsis occurs during

70. (1) Metaphase
Metaphase is the most suitable stage for observing and counting chromosomes in a laboratory setting, such as in onion root tips. During this phase, the chromosomes are at their highest level of condensation, making them thick and clearly defined. Furthermore, their alignment at the equatorial plate allows for an unobstructed view of their morphology, size, and total number.

71. (3) Formation of the contractile ring and formation of the phragmoplast
Telophase involves the reformation of the nuclear envelope around separated chromosomes. In animal cells, this is preceded by the formation of a contractile ring composed of actin and myosin, which initiates cytokinesis. In plant cells, the formation of the phragmoplast, which leads to the cell plate, occurs. These processes ensure the physical separation of the cytoplasm after the nuclei have divided.

72. (2) Tubulin.
The mitotic spindle is a complex apparatus responsible for moving chromosomes during cell division. It is primarily composed of microtubules, which are long, hollow cylinders. These microtubules are built from dimers of the protein tubulin. By polymerizing and depolymerizing, tubulin allows the spindle fibers to grow and shrink, exerting the forces necessary to align and separate the genetic material.

73. (2) root tip.
Onion root tips are widely used in biology laboratories as the ideal material for studying mitosis. This is because the cells in the apical meristem of the root tip are rapidly and continuously dividing. When properly stained and prepared as a squash, these cells provide a clear view of all the different stages of the mitotic division process under a microscope.

74. (2) S-phase.
The cell cycle consists of growth and division phases. Interphase is the growth phase, further divided into G_1, S, and G_2. The S phase, which stands for synthesis, is the specific window during which the cell's genetic material is copied. This replication is essential so that when the cell divides during the M phase, each new cell has its own copy.

75. (3) Kinetochore.
Spindle fibers are the structural elements that organize and move chromosomes during mitosis and meiosis. To perform this function, they must physically attach to the chromosomes. This attachment occurs at a specialized multi-protein complex called the kinetochore. Each sister chromatid has its own kinetochore located at the centromeric region, allowing spindle fibers from opposite poles to pull them apart.

76. (3) cell division.
Microtubules are dynamic components of the cytoskeleton that play various roles in the cell. One of their most critical functions is in cell division, where they assemble to form the mitotic or meiotic spindle. This spindle apparatus is responsible for the movement of chromosomes and their precise segregation into daughter cells, ensuring genetic stability across generations of cells.

77. (3) 7
Mitosis is a process where one cell divides into two identical daughter cells. The number of cells produced follows an exponential progression, where n is the number of divisions. To produce 128 cells from a single starting cell, seven successive divisions are required, because 2 raised to the power of 7 equals exactly 128.

78. (1) telophase.
During the final stage of nuclear division, known as telophase, the process of prophase is essentially reversed. The chromosomes that have migrated to opposite poles begin to decondense back into chromatin. Simultaneously, the nuclear membrane reforms from fragments of the parent cell's endomembrane system, enclosing each set of chromosomes to create two distinct daughter nuclei within the cell.

79. (1) Centriole.
Mitosis in higher plant cells differs from animal cells in several key ways. While both use spindle fibers and centromeres for chromosome movement and form a cell plate during cytokinesis, higher plants lack centrioles. In animal cells, centrioles help organize the spindle, but plant cells manage spindle assembly through alternative microtubule-organizing centers despite the absence of these specific structures.

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CHAPTER 11
Photosynthesis in Higher Plants

2026 (RE-NEET)

1. Which statements regarding photorespiration are correct?
(a) Does not occur in C_3 plants;
(b) CO_2 is consumed and O_2 generated;
(c) Phosphoglycolate is formed;
(d) No synthesis of ATP and NADPH.
(1) (b) and (d) only
(2) (a) and (d) only
(3) (a) and (b) only
(4) (c) and (d) only

2026 (RE-NEET)

2. Select the correct sequence of experiments that led to a gradual understanding of photosynthesis in green plants.
(1) Release of oxygen → production of glucose → absorption spectra of chlorophyll a and b → role of air
(2) Production of glucose → release of oxygen → absorption spectra of chlorophyll a and b
(3) Absorption spectra of chlorophyll a and b → production of glucose → release of oxygen → role of air
(4) Role of air → release of oxygen → production of glucose → absorption spectra of chlorophyll a and b

2026 (RE-NEET)

3. How many turns of Calvin cycle are required for the formation of three molecules of glucose?
(1) 12 (2) 18
(3) 6 (4) 3

2026 (RE-NEET)

4. Which pigment has absorption peak at 700 nm in the photosynthetic reaction centre PS I (P700)?
(1) Xanthophylls
(2) Carotenoids
(3) Chlorophyll b
(4) Chlorophyll a

2026 (RE-NEET)

5. Photorespiration reaction catalyzed by RuBisCo is shown below:
RuBP + O_2 → 3-Phosphoglycerate + X.
Identify X.
(1) Oxaloacetate
(2) Malate
(3) Phosphoenolpyruvate
(4) 2-Phosphoglycolate

2026 (CANCELLED)

6. Find the INCORRECT statement(s) about photosynthesis from the following:
A. The water splitting complex is associated with PS I.
B. C4 plants use the C3 pathway of CO_2 fixation as the main biosynthetic pathway.
C. In C4 plants, photorespiration does not occur.
D. C3 plants exhibit 'Kranz' anatomy.
E. ATP synthesis in chloroplast occurs through chemiosmosis.
(1) B and C only
(2) B only
(3) B and E only
(4) A and D only

2026 (CANCELLED)

7. The enzyme required for carboxylation in the Calvin cycle is:
(1) Hexokinase
(2) PEP carboxylase
(3) RuBP carboxylase-oxygenase
(4) Carboxypeptidase

2026 (CANCELLED)

8. How many ATP and NADPH molecules are required to make one molecule of glucose through the Calvin pathway?
(1) 18 ATP and 12 NADPH
(2) 12 ATP and 18 NADPH
(3) 24 ATP and 18 NADPH
(4) 6 ATP and 12 NADPH

2025

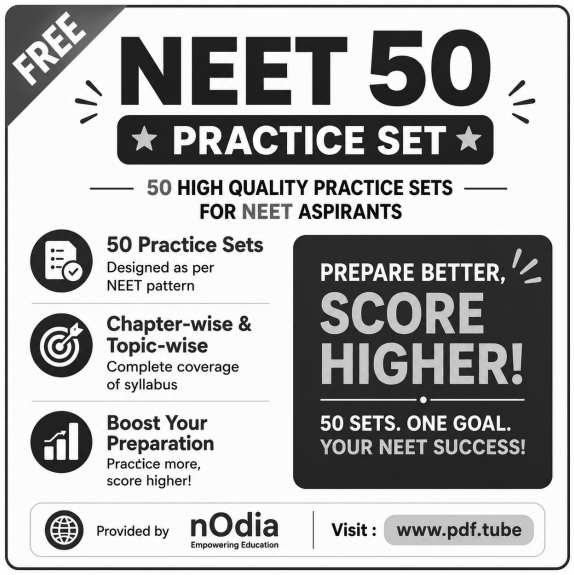
9. Which of the following statements about RuBisCO is true?
(1) It is an enzyme involved in the photolysis of water.
(2) It catalyzes the carboxylation of RuBP.
(3) It is active only in the dark.
(4) It has higher affinity for oxygen than carbon dioxide.

NODIA

Independent assortment during metaphase I randomly distributes maternal and paternal chromosomes. Finally, the segregation of these chromosomes ensures that each gamete receives a unique combination of genetic information.

90. (3) separation of chromatids.
Meiosis II is considered an equational division because it does not change the chromosome number; it merely separates the existing genetic material. While Meiosis I separates homologous chromosomes to reduce the ploidy from diploid to haploid, Meiosis II involves the splitting of centromeres and the separation of sister chromatids. This process ensures that each of the final four daughter cells contains a complete haploid set.

www.nodia.in



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80. (1) S-phase
The cell cycle is a series of events leading to division. Interphase is the longest part of this cycle, comprising the G_1, S, and G_2 phases. The S phase is uniquely identified as the stage where DNA replication occurs. This process ensures that the quantity of genetic material is doubled, allowing for the eventual distribution of identical genomes to daughter cells.

81. (3) prevents the spindle formation in mitosis
Colchicine is a chemical alkaloid often used in biological research to study chromosomes. It acts by inhibiting the polymerization of tubulin into microtubules. Because spindle fibers are composed of microtubules, colchicine effectively prevents the formation of the mitotic spindle. This stops the cell at metaphase, preventing the separation of chromatids and often resulting in a doubling of the chromosome number.

82. (4) crossing-over.
Crossing-over is the process that occurs during the pachytene stage of prophase I in meiosis. It involves the physical exchange of segments between non-sister chromatids of a pair of homologous chromosomes. Because one chromosome in the pair is paternal and the other is maternal, this exchange results in new combinations of genes, which is a major source of genetic variation.

83. (3) S phase
In the lifecycle of a somatic cell, the period known as interphase is when the cell prepares for division. The synthesis of DNA occurs specifically during the S phase of interphase. During this time, every DNA molecule in the nucleus is replicated, doubling the total DNA content so that the subsequent mitotic division can provide each daughter cell with a full set.

84. (2) Metaphase
Scientists and students prefer metaphase for studying chromosome morphology because the chromosomes are in their most condensed and thickened state during this stage. They also align in a single plane at the center of the cell, providing a clear view of their shape, size, and number. This makes metaphase the ideal time for karyotyping and identifying chromosomal abnormalities.

85. (2) Genetic recombinations are possible from generation to generation.
The primary evolutionary benefit of meiosis is the promotion of genetic diversity. Unlike mitosis, which produces identical clones, meiosis involves crossing over and independent assortment. These processes shuffle the genetic material between generations, creating unique offspring. This genetic variation is crucial for the survival and adaptation of a species in a changing environment, driving the process of evolution.

86. (4) separation of chromatids.
Meiosis consists of two distinct divisions. Meiosis I is the reductional division where homologous chromosomes are separated. Meiosis II, which resembles mitosis, is an equational division. Its primary function is the separation of sister chromatids that were held together since the beginning of the process. This results in the formation of four haploid daughter cells, each with a single set of chromosomes.

87. (1) two each in mitosis and meiosis
At metaphase, whether in mitosis or meiosis II, each individual chromosome is composed of two sister chromatids joined at a centromere. In metaphase I of meiosis, although chromosomes are paired as bivalents, each chromosome within that pair still consists of two chromatids. Therefore, the fundamental unit being aligned and prepared for separation always consists of two chromatids per chromosome.

88. (4) same number of chromosomes and half number of chromatids.
During mitotic metaphase, each chromosome consists of two sister chromatids. In anaphase, the centromere splits, and each chromatid becomes an independent chromosome moving to a pole. While the total number of chromosomes in the cell effectively doubles temporarily during anaphase, comparing a single chromosome from metaphase to its resulting anaphase state shows the same chromosome identity but only half the chromatid content.

89. (1) segregation, independent assortment and crossing over
Meiosis produces four daughter cells that are genetically different from the parent and each other. This variability is achieved through three key mechanisms. Crossing over in prophase I exchanges DNA between homologues.

NODIA

RE-EXAM 2024

10. Which of the following are required for the light reaction of photosynthesis?

A. CO_2
B. O_2
C. H_2O
D. Chlorophyll
E. Light

Choose the correct answer from the options given below.

(1) A, C, D and E only
(2) C, D and E only
(3) A and B only
(4) A, C and E only

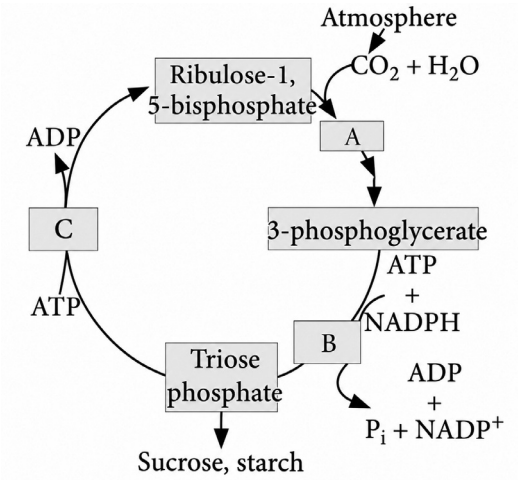
RE-EXAM 2024

11. Which one of the following products diffuses out of the chloroplast during photosynthesis?

(1) ADP
(2) NADPH
(3) O_2
(4) ATP

RE-EXAM 2024

12. Observe the given figure. Identify the different stages labelled with alphabets by selecting the correct option.



(1) A-Carboxylation, B-Regeneration, C-Reduction
(2) A-Reduction, B-Decarboxylation, C-Regeneration
(3) A-Carboxylation, B-Reduction, C-Regeneration
(4) A-Reduction, B-Carboxylation, C-Regeneration

2024

13. How many molecules of ATP and NADPH are required for every molecule of CO_2 fixed in the Calvin cycle?

(1) 2 molecules of ATP and 3 molecules of NADPH
(2) 2 molecules of ATP and 2 molecules of NADPH
(3) 3 molecules of ATP and 3 molecules of NADPH
(4) 3 molecules of ATP and 2 molecules of NADPH

2024

14. Which of the following are required for the dark reaction of photosynthesis?

A. Light
B. Chlorophyll
C. CO_2
D. ATP
E. NADPH

Choose the correct answer from the options given below.

(1) A, B and C only
(2) B, C and D only
(3) C, D and E only
(4) D and E only

2024

15. Given below are two statements.

Statement I : In C_3 plants, some O_2 binds to RuBisCO, hence CO_2 fixation is decreased.

Statement II : In C_4 plants, mesophyll cells show very little photorespiration while bundle sheath cells do not show photorespiration.

In the light of the above statements, choose the correct answer from the options given below.

(1) Both Statement I and Statement II are true.
(2) Both statement I and Statement II are false.
(3) Statement I is true but Statement II is false.
(4) Statement I is false but Statement II is true.

Manipur NEET 2023

16. Match Pigments in List-I with Colours in List-II.

List I (Pigments)		List II (Colours)	
(A)	Chlorophyll a	(i)	Yellow to yellow orange
(B)	Chlorophyll b	(ii)	Yellow green
(C)	Xanthophyll	(iii)	Blue green
(D)	Carotenoid	(iv)	Yellow

Choose the correct answer from the options given below.

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(1) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)
(2) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(3) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
(4) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)

2023

17. The reaction centre in PS II has an absorption maxima at
(1) 660 nm (2) 780 nm
(3) 680 nm (4) 700 nm.

Manipur NEET 2023

18. Which out of the following statements is incorrect?
(1) Grana lamellae have both PS I and PS II.
(2) Cyclic photophosphorylation involves both PS I and PS II.
(3) Both ATP and NADPH + H^+ are synthesised during non-cyclic photophosphorylation.
(4) Stroma lamellae lack PS II and NADP reductase.

2023

19. Which of the following combinations is required for chemiosmosis ?
(1) Proton pump, electron gradient, ATP synthase
(2) Proton pump, electron gradient, NADP synthase
(3) Membrane, proton pump, proton gradient, ATP synthase
(4) Membrane, proton pump, proton gradient, NADP synthase

2023

20. How many ATP and $NADPH_2$ are required for the synthesis of one molecule of glucose during Calvin cycle?
(1) 12 ATP and 16 $NADPH_2$
(2) 18 ATP and 16 $NADPH_2$
(3) 12 ATP and 12 $NADPH_2$
(4) 18 ATP and 12 $NADPH_2$

Manipur NEET 2023

21. Given below are two statements.
Statement I : RuBisCO is the most abundant enzyme in the world.
Statement II : Photorespiration does not occur in C_4 plants.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

2022

22. Which one of the following is not true regarding the release of energy during ATP synthesis through chemiosmosis? It involves
(1) breakdown of proton gradient
(2) breakdown of electron gradient
(3) movement of protons across the membrane to the stroma
(4) reduction of NADP to $NADPH_2$ on the stroma side of the membrane.

2022

23. Given below are two statements :
Statement I : The primary CO_2 acceptor in C_4 plants is phosphoenol pyruvate and is found in the mesophyll cells.
Statement II : Mesophyll cells of C_4 plants lack RuBisCO enzyme.
In the light of the above statements, choose the correct answer from the options given below :
(1) Both statement I and statement II are correct.
(2) Both statement I and statement II are incorrect.
(3) Statement I is correct but statement II is incorrect.
(4) Statement I is incorrect but statement II is correct.

2022

24. What is the role of large bundle sheath cells found around the vascular bundles in C_4 plants ?
(1) To provide the site for photorespiratory pathway
(2) To increase the number of chloroplast for the operation of Calvin cycle
(3) To enable the plant to tolerate high temperature
(4) To protect the vascular tissue from high light intensity

2021

25. Which of the following statements is incorrect?
(1) Cyclic photophosphorylation involves both PSI and PS II.
(2) Both ATP and $NADPH^+ H^+$ are synthesised during non-cyclic photophosphorylation.
(3) Stroma lamellae have PS I only and lack NADP reductase.
(4) Grana lamellae have both PSI and PS II.

NODIA

2021

26. The first stable product of CO_2 fixation in sorghum is
(1) phosphoglyceric acid
(2) pyruvic acid
(3) oxaloacetic acid
(4) succinic acid.

2020

27. In light reaction, plastoquinone facilitates the transfer of electrons from
(1) PS-II to Cytb6f complex
(2) Cytb6f complex to PS-I
(3) PS-I to NADP+
(4) PS-I to ATP synthase.

2020

28. The oxygenation activity of RuBisCO enzyme in photorespiration leads to the formation of
(1) 2 molecules of 3-C compound
(2) 1 molecule of 3-C compound
(3) 1 molecule of 6-C compound
(4) 1 molecule of 4-C compound and 1 molecule of 2-C compound

Odisha NEET 2019

29. One scientist cultured Cladophora in a suspension of Azotobacter and illuminated the culture by splitting light through a prism. He observed that bacteria accumulated mainly in the region of
(1) violet and green light
(2) indigo and green light
(3) orange and yellow light
(4) blue and red light.

2018

30. Oxygen is not produced during photosynthesis by
(1) Green sulphur bacteria
(2) Nostoc
(3) Cycas
(4) Chara.

2018

31. Which of the following is not a product of light reaction of photosynthesis?
(1) ATP
(2) NADH
(3) NADPH
(4) Oxygen

2017

32. Phosphoenol pyruvate (PEP) is the primary CO_2 acceptor in
(1) C_4 plants
(2) C_3 plants
(3) C_3 and C_4 plants
(4) C_2 plants.

2017

33. With reference to factors affecting the rate of photosynthesis, which of the following statements is not correct?
(1) Increasing atmospheric CO_2 concentration up to 0.05% can enhance CO_2 fixation rate.
(2) C_3 plants respond to higher temperature with enhanced photosynthesis while C_4 plants have much lower temperature optimum.
(3) Tomato is a greenhouse crop which can be grown in CO_2-enriched atmosphere for higher yield.
(4) Light saturation for CO_2 fixation occurs at 10% of full sunlight.

NEET-I 2016

34. Emerson's enhancement effect and Red drop have been instrumental in the discovery of
(1) photophosphorylation and cyclic electron transport
(2) oxidative phosphorylation
(3) photophosphorylation and non-cyclic electron transport
(4) two photosystems operating simultaneously.

NEET-I 2016

35. In a chloroplast the highest number of protons are found in
(1) intermembrane space
(2) antennae complex
(3) stroma
(4) lumen of thylakoids.

NEET-I 2016

36. A plant in your garden avoids photorespiratory losses, has improved water use efficiency, shows high rates of photosynthesis at high temperatures and has improved efficiency of nitrogen utilisation. In which of the following physiological groups would you assign this plant?
(1) CAM
(2) Nitrogen fixer
(3) C_3
(4) C_4

NEET-II 2016

37. The process which makes major difference between C_3 and C_4 plants is
(1) glycolysis
(2) Calvin cycle
(3) photorespiration
(4) respiration.

NODIA

2008

59. The C_4 plants are photosynthetically more efficient than C_3 plants because
(1) the CO_2 efflux is not prevented
(2) they have more chloroplasts
(3) the CO_2 compensation point is more
(4) CO_2 generated during photorespiration is trapped and recycled through PEP carboxylase.

2008

60. In leaves of C_4 plants, malic acid synthesis during CO_2 fixation occurs in
(1) bundle sheath
(2) guard cells
(3) epidermal cells
(4) mesophyll cells.

2007

61. The first acceptor of electrons from an excited chlorophyll molecule of photosystem II is
(1) iron-sulphur protein
(2) ferredoxin
(3) quinone
(4) cytochrome.

2007

62. In the leaves of C_4 plants, malic acid formation during CO_2 fixation occurs in the cells of
(1) bundle sheath
(2) phloem
(3) epidermis
(4) mesophyll.

2006

63. In photosystem I, the first electron acceptor is
(1) an iron-sulphur protein
(2) ferredoxin
(3) cytochrome
(4) plastocyanin.

2006

64. During photorespiration, the oxygen consuming reaction(s) occur in
(1) stroma of chloroplasts
(2) stroma of chloroplasts and mitochondria
(3) stroma of chloroplasts and peroxisomes
(4) grana of chloroplasts and peroxisomes.

2005

65. Chemiosmotic theory of ATP synthesis in the chloroplasts and mitochondria is based on
(1) membrane potential
(2) accumulation of Na^+ ions
(3) accumulation of K^+ ions
(4) proton gradient.

2005

66. As compared to a C_3-plant, how many additional molecules of ATP are needed for net production of one molecule of hexose sugar by C_4-plants?
(1) Two
(2) Six
(3) Twelve
(4) Zero

2005

67. Photosynthesis in C_4 plants is relatively less limited by atmospheric CO_2 levels because
(1) effective pumping of CO_2 into bundle sheath cells
(2) RuBisCO in C_4 plants has higher affinity for CO_2
(3) four carbon acids are the primary initial CO_2 fixation products
(4) the primary fixation of CO_2 is mediated via PEP carboxylase.

2004

68. In C_3 plants, the first stable product of photosynthesis during the dark reaction is
(1) malic acid
(2) oxaloacetic acid
(3) 3-phosphoglyceric acid
(4) phosphoglyceraldehyde.

2004

69. Plants adapted to low light intensity have
(1) larger photosynthetic unit size than the sun plants
(2) higher rate of CO_2 fixation than the sun plants
(3) more extended root system
(4) leaves modified to spines.

2003

70. Which fractions of the visible spectrum of solar radiations are primarily absorbed by carotenoids of the higher plants?
(1) Blue and green
(2) Green and red
(3) Red and violet
(4) Violet and blue

2003

71. Which element is located at the centre of the porphyrin ring in chlorophyll ?
(1) Calcium
(2) Magnesium
(3) Potassium
(4) Manganese

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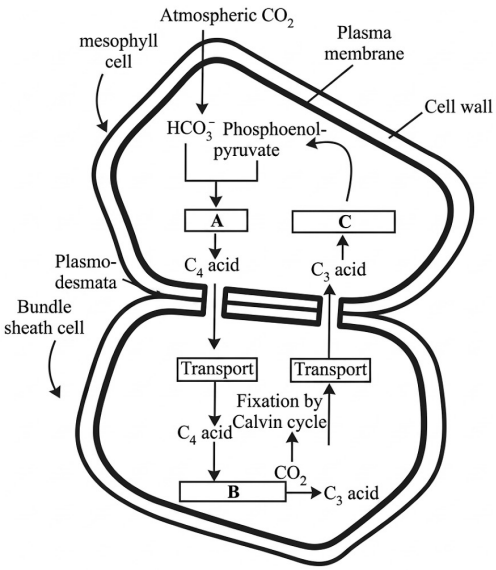
(iii) Cyclic photophosphorylation results into synthesis of ATP and $NADPH_2$.
(iv) Stroma lamellae lack PSII as well as NADP.
(1) (ii) and (iv)
(2) (i) and (ii)
(3) (ii) and (iii)
(4) (iii) and (iv)

2010

50. PGA as the first CO_2 fixation product was discovered in photosynthesis of
(1) bryophyte
(2) gymnosperm
(3) angiosperm
(4) alga.

Mains 2010

51. Study the pathway given below.
In which of the following options correct words for all the three blanks A, B and C are indicated?



(1) A-Decarboxylation; B-Reduction; C-Regeneration
(2) A-Fixation; B-Transamination; C-Regeneration
(3) A-Fixation; B-Decarboxylation; C-Regeneration
(4) A-Carboxylation; B-Decarboxylation; C-Reduction

Mains 2010

52. Kranz anatomy is one of the characteristics of the leaves of
(1) potato
(2) wheat
(3) sugarcane
(4) mustard.

2010

53. C_4 plants are more efficient in photosynthesis than C_3 plants due to
(1) higher leaf area
(2) presence of larger number of chloroplasts in the leaf cells
(3) presence of thin cuticle
(4) lower rate of photorespiration.

2009

54. Oxygenic photosynthesis occurs in
(1) Oscillatoria
(2) Rhodospirillum
(3) Chlorobium
(4) Chromatium.

2009

55. Stroma in the chloroplasts of higher plant contains
(1) light-dependent reaction enzymes
(2) ribosomes
(3) chlorophyll
(4) light-independent reaction enzymes.

NODIA

2009

56. Cyclic photophosphorylation results in the formation of
(1) ATP and NADPH
(2) ATP, NADPH and O_2
(3) ATP
(4) NADPH.

2008

57. Electrons from excited chlorophyll molecule of photosystem II are accepted first by
(1) quinone
(2) ferredoxin
(3) cytochrome-b
(4) cytochrome-f.

2008

58. The chemiosmotic coupling hypothesis of oxidative phosphorylation proposes that adenosine triphosphate (ATP) is formed because
(1) a proton gradient forms across the inner membrane
(2) there is a change in the permeability of the inner mitochondrial membrane toward adenosine diphosphate (ADP)
(3) high energy bonds are formed in mitochondrial proteins
(4) ADP is pumped out of the matrix into the intermembrane space.

that supports aerobic respiration for most living organisms on Earth.

12. (3) A-Carboxylation, B-Reduction, C-Regeneration
The Calvin cycle consists of three primary stages essential for carbon fixation in plants. Carboxylation involves the addition of carbon dioxide to ribulose-1,5-bisphosphate. Reduction follows, where ATP and NADPH are utilized to convert 3-phosphoglycerate into triose phosphate. Finally, regeneration restores the initial carbon acceptor molecule, ensuring the cycle can continue continuously to produce glucose and other vital carbohydrates.

13. (4) 3 molecules of ATP and 2 molecules of NADPH
In the dark reaction of photosynthesis, specific amounts of chemical energy are consumed to fix atmospheric carbon dioxide. For every single molecule of carbon dioxide that enters the Calvin cycle, three molecules of adenosine triphosphate and two molecules of reduced nicotinamide adenine dinucleotide phosphate are required. These energy carriers facilitate the conversion of inorganic carbon into organic sugar molecules efficiently.

14. (3) C, D and E only
The light-independent phase, also known as the biosynthetic phase, takes place in the stroma of the chloroplast. This process requires carbon dioxide as the primary carbon source. It also utilizes the energy-rich molecules, specifically adenosine triphosphate and reduced nicotinamide adenine dinucleotide phosphate, which were produced during the preceding light reactions to synthesize glucose through a series of steps.

15. (1) Both Statement I and Statement II are true.
In C_3 plants, RuBisCO acts as an oxygenase when oxygen levels are high, leading to photorespiration and decreased carbon fixation. C_4 plants have evolved a specialized mechanism to concentrate carbon dioxide around RuBisCO. This occurs in bundle sheath cells, effectively preventing oxygen binding. Consequently, photorespiration is significantly minimized or absent, allowing for higher photosynthetic efficiency under various environmental conditions.

16. (1) (A)-(III), (B)-(II), (C)-(IV), (D)-(I)
Photosynthetic pigments display distinct colors when separated through paper chromatography. Chlorophyll a appears as blue-green, while chlorophyll b typically shows a yellow-green hue. Xanthophylls are characterized by their bright yellow color, and carotenoids range from yellow to yellow-orange. These various pigments work together to capture a wider range of light wavelengths, optimizing the efficiency of the photosynthetic process.

17. (3) 680 nm
Photosystem II is a multi-protein complex located in the thylakoid membranes of chloroplasts. It contains a specific reaction center composed of chlorophyll a molecules. These molecules exhibit a peak absorption of light energy at a wavelength of six hundred and eighty nanometers. This specific wavelength triggers the excitation of electrons, which initiates the non-cyclic electron transport chain during photosynthesis.

18. (2) Cyclic photophosphorylation involves both PS I and PS II.
Cyclic photophosphorylation occurs when only photosystem I is functional and light of wavelengths beyond 680 nanometers is available. Unlike non-cyclic transport, it does not involve photosystem II or the reduction of NADP. Instead, electrons are recycled back to the cytochrome complex, resulting solely in the synthesis of ATP. This process typically takes place within the stroma lamellae of the chloroplast.

19. (3) Membrane, proton pump, proton gradient, ATP synthase
The process of ATP synthesis through chemiosmosis requires several essential components working in unison. A biological membrane is necessary to separate compartments and maintain a proton gradient. A proton pump actively moves ions to create this gradient, while ATP synthase provides a channel for protons to flow back. This downward movement of protons releases energy used to catalyze the formation of ATP.

20. (4) 18 ATP and 12 $NADPH_2$
The synthesis of one molecule of glucose requires six turns of the Calvin cycle. Since each turn fixes one molecule of carbon dioxide and consumes three molecules of adenosine triphosphate and

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2003

72. Which one of the following concerns photophosphorylation ?
(1) ADP + AMP (Light energy) → ATP
(2) ADP + Inorganic PO_4 (Light energy) → ATP
(3) ADP + Inorganic PO_4 → ATP
(4) AMP + Inorganic PO_4 (Light energy)→ ATP

2003

73. In sugarcane plant $14CO_2$ is fixed to malic acid, in which the enzyme that fixes CO_2 is
(1) ribulose biphosphate carboxylase
(2) phosphoenol pyruvic acid carboxylase
(3) ribulose phosphate kinase
(4) fructose phosphatase.

2003

74. Stomata of CAM plants
(1) are always open
(2) open during the day and close at night
(3) open during the night and close during the day
(4) never open.

2003

75. Which one of the following is wrong in relation to photorespiration?
(1) It occurs in chloroplast.
(2) It occurs in day time only.
(3) It is a characteristic of C_4 plants.
(4) It is a characteristic of C_3 plants.

2002

76. Which of the following absorb light energy for photosynthesis?
(1) Chlorophyll
(2) Water molecule
(3) O_2
(4) RuBP

2002

77. In photosynthesis energy from light reaction to dark reaction is transferred in the form of
(1) ADP
(2) ATP
(3) RuDP
(4) chlorophyll.

2001

78. Which pigment system is inactivated in red drop?
(1) PS-I and PS-II (2) PS-I
(3) PS-II (4) None of these

2001

79. Which pair is wrong?
(1) C_3-maize
(2) C_4-kranz anatomy
(3) Calvin cycle-PGA
(4) Hatch and Slack cycle - OAA

2000

80. The first step for initiation of photosynthesis will be
(1) photolysis of water
(2) excitement of chlorophyll molecules due to absorption of light
(3) ATP formation
(4) glucose formation.

2000

81. For assimilation of one CO_2 molecule, the energy required in form of ATP and $NADPH_2$ are
(1) 2 ATP and 2 $NADPH_2$
(2) 5 ATP and 3 $NADPH_2$
(3) 3 ATP and 2$NADPH_2$
(4) 18 ATP and 12 $NADPH_2$.

NODIA

2000

82. For the synthesis of one glucose molecule the Calvin cycle operates for
(1) 2 times
(2) 4 times
(3) 6 times
(4) 8 times.

2000

83. Which is the first CO_2 acceptor enzyme in C_4 plants?
(1) RuDP carboxylase
(2) Phosphoric acid
(3) RuBisCO
(4) PEP- carboxylase

1999

84. Carbon dioxide acceptor in C_3-plants is
(1) PGA
(2) PEP
(3) RuDP
(4) none of these.

1999

85. The rate of photosynthesis is higher in
(1) very high light
(2) continuous light
(3) red light
(4) green light.

1989

115. The substrate for photorespiration is
(1) phosphoglyceric acid
(2) glycolate
(3) serine
(4) glycine.

1988

116. NADP+ is reduced to NADPH in
(1) PS I
(2) PS II
(3) Calvin cycle
(4) non-cyclic photophosphorylation.

1988

117. Carbon dioxide joins the photosynthetic pathway in
(1) PS I
(2) PS II
(3) light reaction
(4) dark reaction.

Not given

118. Match List I with List II.

List I (Pigments)		List II (Colours)	
A.	Chlorophyll a	I.	Yellow-green
B.	Chlorophyll b	II.	Yellow
C.	Xanthophylls	III.	Blue-green
D.	Carotenoids	IV.	Yellow to Yellow-orange

Choose the option with all correct matches.
(1) A-I, B-II, C-IV, D-III
(2) A-I, B-IV, C-III, D-II
(3) A-III, B-IV, C-II, D-I
(4) A-III, B-I, C-II, D-IV

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1993

100. The carbon dioxide acceptor in Calvin cycle/ C_3-plants is
(1) phosphoenol pyruvate (PEP)
(2) ribulose 1, 5-diphosphate (RuDP)
(3) phosphoglyceric acid (PGA)
(4) ribulose monophosphate (RMP).

1993

101. Which one is a C_4-plant?
(1) Papaya (2) Pea
(3) Potato (4) Maize/corn

1992

102. Chlorophyll a occurs in
(1) all photosynthetic autotrophs
(2) in all higher plants
(3) all oxygen liberating autotrophs
(4) all plants except fungi.

1992

103. Photosystem II occurs in
(1) stroma
(2) cytochrome
(3) grana
(4) mitochondrial surface.

1992

104. The enzyme that catalyses carbon dioxide fixation in C_4 plants is
(1) RuBP carboxylase
(2) PEP carboxylase
(3) carbonic anhydrase
(4) carboxydismutase.

1992, 1990

105. The first carbon dioxide acceptor in C_4-plants is
(1) phosphoenol-pyruvate
(2) ribulose 1, 5-diphosphate
(3) oxaloacetic acid
(4) phosphoglyceric acid.

1992

106. At a temperature above 35°C
(1) rate of photosynthesis will decline earlier than that of respiration
(2) rate of respiration will decline earlier than that of photosynthesis
(3) there is no fixed pattern
(4) both decline simultaneously.

1991

107. Photosynthetic pigments found in the chloroplasts occur in
(1) thylakoid membranes
(2) plastoglobules
(3) matrix
(4) chloroplast envelope.

1991

108. Ferredoxin is a constituent of
(1) PS I
(2) PS II
(3) Hill reaction
(4) P680.

1991

109. Which technique has helped in investigation of Calvin cycle?
(1) X-ray crystallography
(2) X-ray technique
(3) Radioactive isotope technique
(4) Intermittent light

1991

110. Dark reactions of photosynthesis occur in
(1) granal thylakoid membranes
(2) stromal lamella membranes
(3) stroma outside photosynthetic lamellae
(4) periplastidial space.

1991

111. During monsoon, the rice crop of eastern states of India shows lesser yield due to limiting factor of
(1) CO_2
(2) light
(3) temperature
(4) water.

NODIA

1990

112. Kranz anatomy is typical of
(1) C_4 plants
(2) C_3 plants
(3) C_2 plants
(4) CAM plants.

1989

113. The size of chlorophyll molecule is
(1) head 15 × 15 Å, tail 25 Å
(2) head 20 × 20 Å, tail 25 Å
(3) head 15 × 15 Å, tail 20 Å
(4) head 10 × 12 Å, tail 25 Å.

1989

114. In C_4 plants, Calvin cycle operates in
(1) stroma of bundle sheath chloroplasts
(2) grana of bundle sheath chloroplasts
(3) grana of mesophyll chloroplasts
(4) stroma of mesophyll chloroplasts.

1997

86. Chlorophyll a molecule at its carbon atom 3 of the pyrrole ring II has one of the following
(1) carboxylic group
(2) magnesium
(3) aldehyde group
(4) methyl group.

1997

87. The core metal of chlorophyll is
(1) Ni
(2) Cu
(3) Fe
(4) Mg.

1997

88. $NADPH_2$ is generated through
(1) photosystem II
(2) anaerobic respiration
(3) glycolysis
(4) photosystem I.

1997

89. The mechanism of ATP formation both in chloroplast and mitochondria is explained by
(1) chemiosmotic theory
(2) Munch's hypothesis (mass flow model)
(3) relay pump theory of Godlewski
(4) Cholodny-Went's model.

1996

90. What will be the number of Calvin cycles to generate one molecule of hexose?
(1) 8
(2) 9
(3) 4
(4) 6

1996

91. In C_4 plants, CO_2 combines with
(1) phosphoenol pyruvate
(2) phosphoglyceraldehyde
(3) phosphoglyceric acid
(4) ribulose diphosphate.

1996

92. In C_4 plants, CO_2 fixation is done by
(1) sclerenchyma
(2) chlorenchyma and hypodermis
(3) mesophyll cells
(4) guard cells.

1996

93. Photorespiration is favoured by
(1) high temperature and low O_2
(2) high humidity and temperature
(3) high O_2 and low CO_2
(4) high CO_2 and low O_2.

1996

94. 'The law of limiting factors' was proposed by
(1) Liebig
(2) Hatch and Slack
(3) Blackman
(4) Arnon.

1995

95. The primary acceptor, during CO_2 fixation in C_3 plants, is
(1) phosphoenolpyruvate (PEP)
(2) ribulose 1, 5-diphosphate (RuDP)
(3) phosphoglyceric acid (PGA)
(4) ribulose monophosphate (RMP).

1995

96. The CO_2 fixation during C_4 pathway occurs in the chloroplast of
(1) guard cells
(2) bundle sheath cells
(3) mesophyll cells
(4) spongy parenchyma.

1994

97. Which of the following pigments acts as a reaction-centre during photosynthesis?
(1) Carotene
(2) Phytochrome
(3) P700
(4) Cytochrome

1994

98. During light reaction of photosynthesis, which of the following phenomenon is observed during cyclic phosphorylation as well as non-cyclic phosphorylation?
(1) Release of O_2
(2) Formation of ATP
(3) Formation of NADPH
(4) Involvement of PS I and PS II pigment systems

1993

99. A photosynthesising plant is releasing ^{18}O more than the normal. The plant must have been supplied with
(1) O_3
(2) H_2O with ^{18}O
(3) CO_2 with ^{18}O
(4) $C_6H_{12}O_6$ with ^{18}O.

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ANSWERS

1. (4) (c) and (d) only
In photorespiration, RuBisCO acts as an oxygenase forming phosphoglycolate (c correct), with no synthesis of ATP or NADPH (d correct). Photorespiration does occur in C_3 plants (a wrong), and O_2 is consumed while CO_2 is released, not the reverse (b wrong).

2. (4) Role of air → release of oxygen → production of glucose → absorption spectra of chlorophyll a and b
Understanding developed gradually: first the role of air (Priestley), then release of oxygen (Ingenhousz), then production of glucose/ starch (Sachs), and finally absorption spectra of chlorophyll a and b (Engelmann). This historical sequence matches option (4).

3. (2) 18
Each turn of the Calvin cycle fixes one molecule of CO_2, and six turns are needed to form one glucose molecule. Therefore, to produce three molecules of glucose, $6 \times 3 = 18$ turns are required.

4. (4) Chlorophyll a
The reaction centre of Photosystem I contains a special form of chlorophyll a that absorbs maximally at 700 nm, hence named P700. Chlorophyll a is the primary photosynthetic pigment, while carotenoids and xanthophylls are accessory pigments.

5. (4) 2-Phosphoglycolate
In photorespiration, RuBisCO acts as an oxygenase and binds RuBP with O_2, producing one molecule of 3-phosphoglycerate (3-carbon) and one molecule of 2-phosphoglycolate (2-carbon). Therefore X is 2-phosphoglycolate.

6. (4) A and D only
The water-splitting complex is linked to PS II, not PS I, so A is incorrect. Kranz anatomy is exhibited by C4 plants, not C3 plants, so D is incorrect. Statements B, C and E are correctly stated about the Calvin pathway, absence of photorespiration in C4, and chemiosmotic ATP synthesis.

7. (3) RuBP carboxylase-oxygenase
In the Calvin cycle, the enzyme RuBP carboxylase-oxygenase (RuBisCO) catalyses the carboxylation of ribulose-1,5-bisphosphate with CO_2, fixing carbon into 3-PGA. It is the most abundant enzyme on Earth. PEP carboxylase works in C_4 plants, not the Calvin cycle's primary carboxylation.

8. (1) 18 ATP and 12 NADPH
To synthesise one molecule of glucose, the Calvin cycle must turn six times. Each turn fixes one CO_2 and uses 3 ATP and 2 NADPH. Therefore six turns require 18 ATP and 12 NADPH molecules in total to produce one glucose molecule.

9. (2) It catalyzes the carboxylation of RuBP.
RuBisCO is a crucial enzyme in the Calvin cycle that exhibits both carboxylase and oxygenase activities. It facilitates the primary step of carbon fixation by catalyzing the reaction between ribulose-1,5-bisphosphate and carbon dioxide to form two molecules of 3-phosphoglyceric acid. This enzymatic process is essential for glucose synthesis in all photosynthetic plants during the light-independent reactions.

10. (2) C, D and E only
The light-dependent phase of photosynthesis occurs within the thylakoid membranes of chloroplasts. This process necessitates the presence of light energy to excite chlorophyll pigments. Water molecules are split through photolysis to provide electrons and protons, while releasing oxygen as a byproduct. These components are fundamental for generating the chemical energy required for the subsequent dark reactions of the cycle.

11. (3) O_2
Oxygen is generated during the light-dependent reactions of photosynthesis specifically through the photolysis of water molecules within the thylakoid lumen. As a gaseous byproduct, it diffuses out of the chloroplast and eventually leaves the plant cell through the stomata into the atmosphere. This release is a critical event

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2015

38. Chromatophores take part in
(1) movement
(2) respiration
(3) photosynthesis
(4) growth.

2015

39. In photosynthesis, the light-independent reactions take place at
(1) photosystem II
(2) stromal matrix
(3) thylakoid lumen
(4) photosystem I.

2014

40. Anoxygenic photosynthesis is characteristic of
(1) Rhodospirillum
(2) Spirogyra
(3) Chlamydomonas
(4) Ulva.

Karnataka NEET 2013

41. Bundle sheath cells
(1) are rich in PEP carboxylase
(2) lack RuBisCO
(3) lack both RuBisCO and PEP carboxylase
(4) are rich in RuBisCO.

Mains 2012

42. Read the following four statements (A - D).
A. Both photophosphorylation and oxidative phosphorylation involve uphill transport of protons across the membrane.
B. In dicot stems, a new cambium originates from cells of pericycle at the time of secondary growth.
C. Stamens in flowers of Gloriosa and Petunia are polyandrous.
D. Symbiotic nitrogen fixers occur in free-living state also in soil.
How many of the above statements are right?
(1) Two
(2) Three
(3) Four
(4) One

Mains 2012

43. Which one of the following organisms is correctly matched with its three characteristics?
(1) Pea: C_3 pathway, endospermic seed, vexillary aestivation
(2) Tomato: twisted aestivation, axile placentation, berry
(3) Onion: bulb, imbricate aestivation, axile placentation
(4) Maize: C_3 pathway, closed vascular bundles, scutellum

2012

44. A process that makes important difference between C_3 and C_4 plants is
(1) transpiration
(2) glycolysis
(3) photosynthesis
(4) photorespiration.

2012

45. The correct sequence of cell organelles during photorespiration is
(1) chloroplast, Golgi bodies, mitochondria
(2) chloroplast, rough endoplasmic reticulum, dictyosomes
(3) chloroplast, mitochondria, peroxisome
(4) chloroplast, vacuole, peroxisome.

NODIA

Mains 2011

46. Which one of the following is essential for photolysis of water?
(1) Manganese
(2) Zinc
(3) Copper
(4) Boron

2011

47. CAM helps the plants in
(1) conserving water
(2) secondary growth
(3) disease resistance
(4) reproduction.

Mains 2011

48. In kranz anatomy, the bundle sheath cells have
(1) thin walls, many intercellular spaces and no chloroplasts
(2) thick walls, no intercellular spaces and large number of chloroplasts
(3) thin walls, no intercellular spaces and several chloroplasts
(4) thick walls, many intercellular spaces and few chloroplasts.

Mains 2010

49. Read the following four statements, (i), (ii), (iii) and (iv) and select the right option having both correct statements.
Statements :
(i) Z scheme of light reaction takes place in presence of PSI only.
(ii) Only PSI is functional in cyclic photophosphorylation.

two molecules of reduced nicotinamide adenine dinucleotide phosphate, the total requirement is eighteen ATP and twelve NADPH. This substantial energy investment is necessary to convert inorganic carbon into a stable hexose sugar.

21. (3) Both statement I and statement II are correct.
RuBisCO is recognized as the most abundant protein on Earth because it is vital for carbon fixation in all photosynthetic organisms. In C_4 plants, a specialized anatomical arrangement known as Kranz anatomy increases the concentration of carbon dioxide near the enzyme. This mechanism effectively suppresses the oxygenase activity of RuBisCO, thereby preventing the wasteful process of photorespiration from occurring.

22. (2) breakdown of electron gradient
ATP synthesis in chloroplasts occurs due to the establishment of a proton gradient across the thylakoid membrane. This process involves the movement of protons from the lumen into the stroma through the ATP synthase enzyme. While it requires a membrane and a proton pump, it does not depend on the breakdown of an electron gradient. The energy released facilitates phosphorylation.

23. (1) Both statement I and statement II are correct.
In C_4 plants, the initial carbon dioxide fixation occurs in the mesophyll cells where phosphoenolpyruvate acts as the primary acceptor. This reaction is catalyzed by PEP carboxylase, an enzyme with a high affinity for carbon dioxide. Importantly, these mesophyll cells lack the enzyme RuBisCO, which is instead localized within the bundle sheath cells to optimize the efficiency of the Calvin cycle.

24. (2) To increase the number of chloroplast for the operation of Calvin cycle
Bundle sheath cells in C_4 plants are characterized by their large size and the presence of numerous thick-walled chloroplasts. These specialized cells provide an ideal environment for the Calvin cycle to occur at high carbon dioxide concentrations. By housing a high density of chloroplasts, these cells maximize the efficiency of sugar synthesis while minimizing oxygen-related interference, which enhances overall plant productivity.

25. (1) Cyclic photophosphorylation involves both PSI and PS II.
Cyclic photophosphorylation is a process that operates exclusively with photosystem I and does not require photosystem II. This mechanism occurs in the stroma lamellae, which lack the NADP reductase enzyme and photosystem II. Consequently, the flow of electrons only produces adenosine triphosphate without generating reduced nicotinamide adenine dinucleotide phosphate or releasing oxygen through the splitting of water molecules.

26. (3) oxaloacetic acid
Sorghum is a C_4 plant that utilizes a specialized pathway for carbon fixation to enhance efficiency. The primary step involves the reaction between carbon dioxide and phosphoenolpyruvate in the mesophyll cells. This reaction, catalyzed by the enzyme PEP carboxylase, results in the formation of oxaloacetic acid, a four-carbon compound. This molecule serves as the first stable product of the pathway.

27. (1) PS-II to Cytb6f complex
Plastoquinone is a mobile electron carrier situated within the thylakoid membrane of chloroplasts. During the light-dependent reactions of photosynthesis, it receives electrons from the excited reaction center of photosystem II. It then transfers these electrons to the cytochrome b6f complex. This movement is integral to the electron transport chain and contributes to the establishment of the proton gradient for ATP.

28. (2) 1 molecule of 3-C compound
When RuBisCO functions as an oxygenase during photorespiration, it binds oxygen to ribulose-1,5-bisphosphate instead of carbon dioxide. This reaction produces one molecule of 3-phosphoglycerate, which is a three-carbon compound, and one molecule of phosphoglycolate, a two-carbon compound. Only the three-carbon compound enters the Calvin cycle directly, while the two-carbon molecule must undergo a complex recovery process in other organelles.

29. (4) blue and red light.
In Engelmann's classic experiment using the green alga Cladophora, a prism was used to split white light into its spectral components. Aerobic bacteria were observed to accumulate primarily in the regions illuminated by blue and red light. This observation indicated that

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reaction is catalyzed by the enzyme RuBisCO, ultimately leading to the formation of stable organic compounds.

85. (3) red light
The rate of photosynthesis varies depending on the wavelength of light absorbed by plant pigments. Chlorophyll a and b have high absorption peaks in the blue and red regions of the visible spectrum. Experimental data show that the maximum rate of photosynthesis occurs under red light, followed by blue light. Green light is mostly reflected or transmitted, resulting in a lower rate.

86. (4) methyl group.
Chlorophyll a and chlorophyll b are the two primary pigments involved in photosynthesis, differing slightly in their chemical structure. Chlorophyll a is characterized by the presence of a methyl group at the third carbon position of the second pyrrole ring. In contrast, chlorophyll b possesses an aldehyde group at this same location. This small structural difference affects their respective light absorption properties.

87. (4) Mg.
The chlorophyll molecule is essential for capturing solar energy and features a unique chemical structure. It consists of a porphyrin ring, which is a cyclic arrangement of four pyrrole rings. At the center of this ring system, a magnesium ion is situated and held by coordination bonds. This central metal atom is fundamental to the pigment's ability to absorb light energy efficiently.

88. (4) photosystem I.
During the non-cyclic photophosphorylation process, light energy is used to drive the flow of electrons through two photosystems. While photosystem II is responsible for water splitting and oxygen release, photosystem I facilitates the final transfer of electrons. These electrons are passed to NADP reductase, which then reduces NADP to form $NADPH_2$. This molecule provides the reducing power for dark reactions.

89. (1) chemiosmotic theory
The production of ATP in both chloroplasts and mitochondria follows a common mechanism known as the chemiosmotic theory. This process involves the movement of protons across a semi-permeable membrane to create an electrochemical gradient. As protons flow back through the enzyme ATP synthase, the released energy is used to synthesize ATP from ADP and inorganic phosphate. This theory explains energy transduction globally.

90. (4) 6
Hexose sugars, such as glucose and fructose, are composed of six carbon atoms. In the photosynthetic process, the Calvin cycle fixes one molecule of carbon dioxide during each complete turn. Consequently, for the plant to produce a single molecule of a six-carbon hexose sugar, the cycle must be performed six times consecutively. This allows for the accumulation of sufficient carbon atoms.

91. (1) phosphoenol pyruvate
In the C_4 photosynthetic pathway, carbon dioxide is initially captured within the mesophyll cells of the leaf. It combines with a three-carbon molecule called phosphoenolpyruvate to form a four-carbon intermediate. This reaction is catalyzed by the highly efficient enzyme PEP carboxylase. This specific step is the hallmark of the C_4 cycle and allows for effective carbon fixation even at low concentrations.

92. (3) mesophyll cells
The initial fixation of atmospheric carbon dioxide in C_4 plants occurs within the mesophyll cells, which are located just beneath the leaf epidermis. These cells contain the enzyme PEP carboxylase, which facilitates the capture of carbon. The resulting four-carbon acids are then transported into the specialized bundle sheath cells for the subsequent stages of the photosynthetic process and the Calvin cycle.

93. (3) high O_2 and low CO_2
Photorespiration is a competitive process that occurs when the enzyme RuBisCO binds with oxygen instead of carbon dioxide. This pathway is particularly favored under environmental conditions where oxygen concentrations are high and carbon dioxide levels are relatively low. Elevated temperatures also increase the likelihood of this occurring in C_3 plants, leading to a reduction in the efficiency of carbon fixation.

94. (3) Blackman
The rate of photosynthesis is influenced by several environmental variables, such as light intensity, temperature, and carbon dioxide concentration.

NODIA

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and carotenoids, which are essential for capturing solar energy. By providing a site for the light-dependent reactions, chromatophores enable these microorganisms to perform photosynthesis and produce the organic compounds needed for their survival.

39. (2) stromal matrix
The light-independent reactions of photosynthesis, commonly known as the Calvin cycle, occur within the stromal matrix of the chloroplast. This fluid-filled region contains the necessary enzymes, such as RuBisCO, required for the fixation of carbon dioxide into organic molecules. While the light reactions take place in the thylakoids, the stroma provides the appropriate environment for synthesizing glucose using energy.

40. (1) Rhodospirillum
Anoxygenic photosynthesis is a process where light energy is captured without the evolution of oxygen. This occurs in certain bacteria, such as Rhodospirillum, which use electron donors other than water, like hydrogen or reduced sulphur compounds. Because water is not split during this process, no oxygen is released. This metabolic pathway is characteristic of several groups of purple and green bacteria.

41. (4) are rich in RuBisCO.
Bundle sheath cells are a key component of the Kranz anatomy found in C_4 plants. These cells are characterized by having thick walls and a high concentration of chloroplasts. Unlike mesophyll cells, they are rich in the enzyme RuBisCO, which is responsible for the Calvin cycle. They lack PEP carboxylase, which is instead located in the surrounding mesophyll cells for fixation.

42. (2) Three
Several biological statements can be evaluated for accuracy. Photophosphorylation and oxidative phosphorylation both utilize proton gradients across membranes for energy production. Stamens in Gloriosa and Petunia exhibit a polyandrous condition, meaning they are numerous and free. Furthermore, many symbiotic nitrogen-fixing bacteria, like Rhizobium, can survive independently in the soil environment. These facts confirm that three statements are correct.

43. (3) Onion: bulb, imbricate aestivation, axile placentation
Onion is accurately described by its characteristic underground bulb and specific floral features. It exhibits valvate aestivation, where the margins of tepals touch each other without overlapping. Additionally, the ovary shows axile placentation, where ovules are attached to the central axis of a multi-locular ovary. These features are standard botanical identifiers for members of the Liliaceae family.

44. (4) photorespiration.
The primary distinction between C_3 and C_4 plants lies in the occurrence of photorespiration. In C_3 plants, the enzyme RuBisCO often binds with oxygen, leading to a loss of fixed carbon and energy. C_4 plants have evolved a specialized mechanism to bypass this wasteful process by concentrating carbon dioxide around RuBisCO, thus ensuring higher efficiency and productivity under various environmental conditions.

45. (3) chloroplast, mitochondria, peroxisome
Photorespiration is a complex metabolic pathway that involves the interaction of three different organelles in a specific order. It begins in the chloroplast where RuBisCO reacts with oxygen. The resulting compounds are then processed in the peroxisome and subsequently in the mitochondria. This sequence is essential for recovering carbon from phosphoglycolate, although the process itself consumes energy without producing sugar.

46. (1) Manganese
The photolysis of water is a vital step in the light-dependent reactions of photosynthesis, occurring at the oxygen-evolving complex of photosystem II. This process requires specific mineral ions to function correctly. Manganese is a critical cofactor that facilitates the splitting of water molecules into oxygen, protons, and electrons. Chloride and calcium ions also play supportive roles in maintaining this enzymatic activity.

47. (1) conserving water
Crassulacean Acid Metabolism is a specialized photosynthetic adaptation found in plants living in arid environments. These plants keep their stomata closed during the hot day to minimize transpiration and open them at night to absorb carbon dioxide. This temporal

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104. (2) PEP carboxylase
In the C_4 photosynthetic pathway, the initial step of carbon dioxide fixation is carried out by a specific enzyme called phosphoenolpyruvate carboxylase. This enzyme is situated in the mesophyll cells of the leaf and has a high affinity for bicarbonate ions. It catalyzes the reaction that forms a four-carbon compound, effectively capturing carbon for transport to the site of the Calvin cycle.

105. (1) phosphoenol-pyruvate
C_4 plants utilize a specialized mechanism to capture atmospheric carbon dioxide efficiently. The primary molecule that accepts carbon dioxide in these plants is a three-carbon compound known as phosphoenolpyruvate. This reaction takes place in the mesophyll cells and is catalyzed by the enzyme PEP carboxylase. The resulting product is oxaloacetic acid, which then proceeds through the remainder of the specific C_4 pathway.

106. (1) rate of photosynthesis will decline earlier than that of respiration
Environmental temperature plays a critical role in determining the rates of various metabolic processes in plants. As temperatures rise above thirty-five degrees Celsius, the rate of photosynthesis typically begins to decline. This occurs because the enzymes involved in carbon fixation are more sensitive to heat than those involved in cellular respiration. Consequently, the photosynthetic capacity of the plant decreases before respiration rates.

107. (1) thylakoid membranes
The chloroplast is the specialized organelle where photosynthesis occurs in eukaryotic cells. Within the chloroplast, the light-harvesting pigments, such as chlorophyll and carotenoids, are embedded in the thylakoid membranes. These membranes are organized into stacks called grana and facilitate the photochemical reactions. By being anchored in the lipid bilayer, these pigments can efficiently capture and transfer energy to the reaction centers.

108. (1) PS I
Ferredoxin is a small, iron-sulphur protein that serves as a crucial electron carrier in the photosynthetic electron transport chain. It is primarily associated with the stromal side of the thylakoid membrane near photosystem I. After receiving high-energy electrons from the excited reaction center of photosystem I, ferredoxin transfers them to the enzyme NADP reductase, facilitating the production of reduced NADP.

109. (3) Radioactive isotope technique
The elucidation of the complex steps of the Calvin cycle was made possible through the use of advanced scientific methods. Researchers utilized the radioactive isotope carbon-fourteen to label carbon dioxide, allowing them to trace the path of carbon as it was incorporated into various organic compounds. This technique provided the precision necessary to identify each intermediate molecule formed during the photosynthetic cycle.

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110. (3) stroma outside photosynthetic lamellae
Photosynthesis consists of two distinct stages that occur in different parts of the chloroplast. The light-dependent reactions take place in the thylakoid membranes. In contrast, the dark reactions, or the Calvin cycle, occur in the stroma. This aqueous fluid surrounding the thylakoids contains all the necessary enzymes, such as RuBisCO, to fix carbon dioxide into stable organic sugar molecules.

111. (2) light
During the monsoon season in eastern India, the weather is frequently characterized by heavy cloud cover and persistent rainfall. These conditions significantly reduce the amount of solar radiation reaching the rice crops. Since light is an essential driver for the photochemical reactions of photosynthesis, its limited availability becomes the primary factor that restricts the overall grain yield of the rice plants.

112. (1) C_4 plants
Kranz anatomy is a distinctive leaf structure that evolved in plants following the C_4 photosynthetic pathway. It is characterized by the presence of specialized bundle sheath cells that form a protective ring around the vascular tissues. This arrangement facilitates a division of labor between mesophyll and bundle sheath cells, allowing the plant to concentrate carbon dioxide and effectively eliminate wasteful photorespiration.

113. (3) head 15 x 15 A, tail 20 A
The chlorophyll molecule has a specific geometric structure that allows it to be embedded within

of protons across the membrane, creating a gradient that results exclusively in the synthesis of adenosine triphosphate via chemiosmosis.

57. (1) quinone
In the light-dependent reactions of photosynthesis, photosystem II captures light energy to excite electrons within its reaction center. These high-energy electrons are immediately captured by a primary electron acceptor. The first stable molecule to receive these electrons in the transport chain is pheophytin, which then transfers them to a quinone molecule. This initial step is vital for driving electron flow.

58. (1) a proton gradient forms across the inner membrane
The chemiosmotic coupling hypothesis explains how energy is harnessed to produce ATP during oxidative phosphorylation. It proposes that the movement of electrons through the transport chain drives the pumping of protons from the mitochondrial matrix into the intermembrane space. This creates a significant proton gradient across the inner membrane. The subsequent flow of protons back into the matrix powers ATP synthase.

59. (2) they have more chloroplasts
C_4 plants exhibit higher photosynthetic efficiency due to several anatomical and physiological factors. They possess a greater number of chloroplasts, particularly within the specialized bundle sheath cells. This high chloroplast density, combined with the lack of photorespiration, allows these plants to fix carbon dioxide more effectively. Consequently, they can achieve higher growth rates and biomass even under intense light conditions.

60. (4) mesophyll cells.
In the C_4 photosynthetic pathway, the initial steps of carbon fixation take place within the mesophyll cells. Atmospheric carbon dioxide is converted into bicarbonate and then combined with phosphoenolpyruvate. This reaction produces oxaloacetic acid, which is rapidly converted into malic acid. This four-carbon acid then travels to the bundle sheath cells to release carbon dioxide for the final Calvin cycle.

61. (3) quinone
When light strikes the reaction center of photosystem II, it excites a pair of chlorophyll a molecules, causing them to release electrons. These electrons are quickly captured by a primary acceptor molecule. Although pheophytin is the very first intermediate, quinone serves as the first stable acceptor in the sequence. This transfer is the starting point for the non-cyclic electron transport.

62. (4) mesophyll.
The C_4 pathway begins with the capture of carbon dioxide in the mesophyll cells of the leaf. Through the action of PEP carboxylase, a four-carbon compound called oxaloacetic acid is formed. This molecule is then reduced to form malic acid. The newly synthesized malic acid is subsequently transported to the bundle sheath cells where it is xdecarboxylated to provide carbon dioxide.

63. (1) an iron-sulphur protein
Photosystem I operates by absorbing light energy to excite electrons in its reaction center, known as P700. These electrons are then passed to a primary electron acceptor located within the same complex. The first molecule to receive these electrons is an iron-sulphur protein. From here, the electrons continue their journey through other carriers like ferredoxin to eventually reduce NADP to NADPH.

64. (3) stroma of chloroplasts and peroxisomes
Photorespiration involves oxygen consumption at two distinct stages within different organelles. The first instance occurs in the stroma of the chloroplast when RuBisCO adds oxygen to ribulose-1,5-bisphosphate. The second instance of oxygen consumption happens within the peroxisomes during the oxidation of glycolate to glyoxylate. These steps are characteristic of the wasteful pathway that occurs primarily in C_3 plants under specific conditions.

65. (4) proton gradient.
The chemiosmotic theory, proposed by Peter Mitchell, provides a universal mechanism for ATP synthesis in both chloroplasts and mitochondria. This theory is fundamentally based on the establishment of a proton gradient across a biological membrane. The energy stored in this electrochemical gradient is utilized by the enzyme ATP synthase to catalyze the phosphorylation of ADP, producing the cell's main energy currency.

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separation of carbon fixation allows the plant to conserve significant amounts of water while still performing the necessary biosynthetic processes for survival.

48. (2) thick walls, no intercellular spaces and large number of chloroplasts
In the leaves of C_4 plants, Kranz anatomy features specialized bundle sheath cells arranged in a wreath-like manner around the vascular bundles. These cells possess thick walls that are impervious to gaseous exchange and lack intercellular spaces. They contain a high density of large chloroplasts, providing an optimal site for the Calvin cycle to proceed efficiently at high carbon concentrations.

49. (1) (ii) and (iv)
In the light reactions of photosynthesis, specific components have distinct roles. Cyclic photophosphorylation involves only photosystem I and does not produce NADPH. Stroma lamellae are specialized membranes that lack photosystem II and the enzyme NADP reductase, which restricts them to performing only cyclic electron transport. These characteristics are essential for understanding how plants regulate energy production based on needs.

50. (4) alga.
The discovery of 3-phosphoglyceric acid as the first stable product of carbon fixation was a milestone in plant biology. Melvin Calvin and his colleagues utilized the radioactive isotope carbon-fourteen to trace the path of carbon during photosynthesis. Their research primarily focused on the unicellular green alga Chlorella. This work eventually led to the complete mapping of the light-independent reactions.

51. (3) Fixation Decarboxylation Regeneration
The C_4 photosynthetic pathway involves several distinct biochemical steps across different cell types. Initially, carbon dioxide fixation occurs in the mesophyll cells to form a four-carbon acid. This acid is transported to bundle sheath cells where decarboxylation releases carbon dioxide for the Calvin cycle. Finally, regeneration of the initial three-carbon acceptor molecule occurs to maintain the continuous operation of the pathway.

52. (3) sugarcane
Kranz anatomy is a specialized leaf structure characteristic of C_4 plants, which are adapted to high temperatures and intense sunlight. Sugarcane is a classic example of a crop that utilizes this pathway to achieve high rates of photosynthesis. In these plants, the bundle sheath cells form a distinctive layer around the vascular bundles, facilitating efficient carbon concentration and minimal photorespiration.

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53. (4) lower rate of photorespiration.
C_4 plants demonstrate greater photosynthetic efficiency compared to C_3 plants primarily because they effectively eliminate photorespiration. Their unique leaf anatomy and biochemical pathway allow them to maintain high carbon dioxide levels near the enzyme RuBisCO. This ensures that the carboxylase activity of the enzyme dominates over its oxygenase activity, leading to higher rates of carbon fixation and biomass production.

54. (1) Oscillatoria
Oxygenic photosynthesis is a process that uses water as an electron donor, resulting in the release of oxygen as a byproduct. This type of photosynthesis is characteristic of plants, algae, and cyanobacteria. Oscillatoria is a genus of filamentous cyanobacteria that performs this process efficiently. In contrast, other bacterial groups like Rhodospirillum and Chlorobium perform anoxygenic photosynthesis, which does not evolve oxygen.

55. (4) light-independent reaction enzymes.
The stroma is the colorless, protein-rich matrix of the chloroplast that surrounds the thylakoid system. It contains various essential components, including circular DNA, ribosomes, and starch granules. Most importantly, it houses the enzymes necessary for the light-independent reactions of photosynthesis, such as RuBisCO. These enzymes facilitate the conversion of carbon dioxide into glucose using the energy produced during light reactions.

56. (3) ATP
Cyclic photophosphorylation is a specific pathway of electron flow that occurs within the thylakoid membranes when only photosystem I is active. During this process, electrons are excited and eventually returned to the same reaction center. This electron movement drives the pumping

and mitochondria. Unlike C_3 plants, C_4 plants have evolved structural and biochemical adaptations that effectively eliminate photorespiration. Therefore, it is incorrect to state that this process is a characteristic feature of C_4.

76. (1) Chlorophyll
Photosynthesis begins when specialized pigment molecules within the chloroplast capture solar energy. Chlorophyll is the primary pigment responsible for this absorption, particularly in the blue and red wavelengths of the visible spectrum. Once light energy is absorbed, it excites electrons to a higher energy state, initiating the photochemical reactions that ultimately produce the chemical energy needed for plant growth.

77. (2) ATP
The light reactions of photosynthesis capture solar energy and convert it into chemical energy stored in specific molecules. These high-energy compounds, including adenosine triphosphate and reduced nicotinamide adenine dinucleotide phosphate, are then transported to the stroma. Here, they provide the necessary power and reducing capacity for the dark reactions to convert carbon dioxide into complex organic sugar molecules.

78. (3) PS-II
The red drop phenomenon refers to a sharp decline in the quantum yield of photosynthesis when plants are exposed to light wavelengths greater than 680 nanometers. This occurs because photosystem II cannot effectively absorb these longer wavelengths, leading to its inactivation. Since both photosystems must work together for efficient non-cyclic electron transport, the loss of photosystem II activity significantly reduces the rate.

79. (1) C_3-maize
Maize is a well-known example of a C_4 plant, characterized by its specialized Kranz anatomy and the Hatch-Slack pathway. In this pathway, the first stable product is the four-carbon compound oxaloacetic acid. C_3 plants, such as wheat or rice, produce phosphoglyceric acid as their first stable product. Therefore, pairing maize with the C_3 pathway is botanically incorrect based on its metabolism.

80. (2) excitement of chlorophyll molecules due to absorption of light
Photosynthesis is initiated when light energy is absorbed by the antenna pigments in the thylakoid membrane. This energy is transferred to the reaction center, leading to the excitement of chlorophyll molecules. This excitation causes the release of high-energy electrons, which then enter the electron transport chain. All subsequent steps, including the photolysis of water and ATP formation, depend on this event.

81. (3) 3 ATP and $2NADPH_2$
The conversion of inorganic carbon dioxide into organic sugar molecules occurs through the Calvin cycle in the stroma of chloroplasts. This process requires a specific input of chemical energy and reducing power. For each molecule of carbon dioxide that is successfully assimilated, the cycle consumes exactly three molecules of adenosine triphosphate and two molecules of reduced nicotinamide adenine dinucleotide phosphate.

82. (3) 6 times
A single molecule of glucose is a hexose sugar containing six carbon atoms. During the light-independent reactions of photosynthesis, each turn of the Calvin cycle incorporates one molecule of atmospheric carbon dioxide. Therefore, to synthesize a complete molecule of glucose, the cycle must operate six times. This ensures that sufficient carbon atoms are fixed and processed into the final sugar product.

83. (4) PEP- carboxylase
In C_4 plants, the initial step of carbon fixation is facilitated by a specialized enzyme located in the mesophyll cells. This enzyme, phosphoenolpyruvate carboxylase, has a remarkably high affinity for carbon dioxide. It catalyzes the reaction between carbon dioxide and phosphoenolpyruvate to form a four-carbon compound. This mechanism allows C_4 plants to thrive in environments where carbon dioxide availability is relatively low.

84. (3) RuDP
The Calvin cycle is the primary pathway for carbon fixation in C_3 plants. In this cycle, the first step involves the reaction of atmospheric carbon dioxide with a five-carbon sugar molecule. This molecule, known as ribulose-1,5-bisphosphate or RuDP, acts as the primary carbon acceptor. The

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these specific wavelengths are most effective for photosynthesis, as they result in the highest rate of oxygen production.

30. (1) Green sulphur bacteria
Green sulphur bacteria perform anoxygenic photosynthesis, meaning they do not release oxygen as a byproduct. Unlike higher plants, algae, and cyanobacteria which use water as an electron donor, these bacteria utilize hydrogen sulphide or other reduced sulphur compounds. Consequently, the photolysis of these molecules produces elemental sulphur or sulphate instead of oxygen, reflecting a different evolutionary adaptation.

31. (2) NADH
The light-dependent reactions of photosynthesis occur in the thylakoid membranes and generate specific high-energy products. These include adenosine triphosphate and reduced nicotinamide adenine dinucleotide phosphate, which are used in the dark reactions. Oxygen is also released as a byproduct of water splitting. However, reduced nicotinamide adenine dinucleotide is typically produced during cellular respiration processes rather than during photosynthesis.

32. (1) C_4 plants
Phosphoenolpyruvate serves as the initial acceptor of atmospheric carbon dioxide in plants that follow the C_4 pathway. This reaction occurs in the mesophyll cells and is catalyzed by the enzyme PEP carboxylase. This adaptation allows C_4 plants to efficiently capture carbon dioxide even at low concentrations, minimizing the occurrence of photorespiration and enhancing photosynthetic performance in hot, bright environments.

33. (2) C_3 plants respond to higher temperature with enhanced photosynthesis while C_4 plants have much lower temperature optimum.
Environmental factors significantly influence the rate of photosynthesis in various plant groups. C_4 plants generally have a higher temperature optimum compared to C_3 plants because they possess a carbon-concentrating mechanism that minimizes photorespiration. In contrast, C_3 plants are more sensitive to high temperatures, which can increase the oxygenase activity of RuBisCO and consequently lead to a decline in fixation.

34. (4) two photosystems operating simultaneously.
The discovery of the Emerson enhancement effect and the red drop phenomenon provided crucial evidence for the existence of two distinct photochemical systems in photosynthesis. Researchers observed that the rate of photosynthesis increased significantly when both long-wavelength and short-wavelength light were provided simultaneously. This indicated that two photosystems work in tandem to drive the non-cyclic flow of electrons.

35. (4) lumen of thylakoids.
During the light-dependent reactions of photosynthesis, protons accumulate in high concentrations within the thylakoid lumen. This build-up results from three main processes: the photolysis of water, the transport of protons by plastoquinone from the stroma, and the removal of protons from the stroma for NADP reduction. This concentration gradient provides the potential energy necessary for ATP synthesis through chemiosmosis.

36. (4) C_4
Plants categorized as C_4 possess unique physiological adaptations that allow them to thrive in challenging environments. These include a specialized internal leaf structure that prevents photorespiration, thereby improving carbon fixation efficiency. They also exhibit superior water use efficiency and can maintain high photosynthetic rates at elevated temperatures. These traits combined make them highly productive compared to plants using other pathways.

37. (3) photorespiration
Photorespiration is a major physiological process that distinguishes C_3 plants from C_4 plants. In C_3 plants, RuBisCO reacts with oxygen when carbon dioxide levels are low, leading to energy loss. C_4 plants avoid this wasteful process by using a carbon-concentrating mechanism that ensures high carbon dioxide levels near RuBisCO in specialized cells, thereby significantly enhancing their overall photosynthetic efficiency.

38. (3) photosynthesis
Chromatophores are specialized internal membrane systems found in certain photosynthetic bacteria, such as cyanobacteria and purple bacteria. These structures contain light-harvesting pigments, including chlorophyll

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In 1905, the British plant physiologist F.F. Blackman proposed the Law of Limiting Factors. This principle states that when a biological process is controlled by multiple factors, its rate is limited by the factor that is closest to its minimum value.

95. (2) ribulose 1, 5-diphosphate (RuDP)
In C_3 plants, the light-independent reactions begin with the fixation of carbon dioxide onto a specific organic molecule. This primary acceptor is ribulose-1,5-bisphosphate, often abbreviated as RuDP or RuBP. The reaction is catalyzed by the enzyme RuBisCO, resulting in the production of two molecules of 3-phosphoglyceric acid. This step is essential for the continuous operation of the photosynthetic cycle.

96. (3) mesophyll cells
In plants utilizing the C_4 pathway, the initial capture and fixation of carbon dioxide occur within the chloroplasts of the mesophyll cells. These cells are specialized for the first phase of the process, using the enzyme PEP carboxylase to form four-carbon acids. These acids are later moved to the bundle sheath cells, where carbon dioxide is released for the Calvin cycle.

97. (3) P700
In the thylakoid membranes, light-harvesting complexes consist of many pigment molecules that funnel energy toward a specific point. This point is known as the reaction center, where the actual photochemical change occurs. In photosystem I, the reaction center is a specialized pair of chlorophyll a molecules designated as P700, because they have a peak absorption of light at seven hundred nanometers.

98. (2) Formation of ATP
Photophosphorylation involves the production of chemical energy during the light-dependent reactions of photosynthesis. Both cyclic and non-cyclic pathways utilize the flow of electrons to establish a proton gradient across the thylakoid membrane. This gradient provides the energy necessary for the enzyme ATP synthase to catalyze the formation of adenosine triphosphate. However, only the non-cyclic pathway produces oxygen and reduced NADP.

99. (2) H_2O with ^{18}O
Experimental studies using isotopes have confirmed the true source of the oxygen released during photosynthesis. When plants are provided with water containing the heavy isotope oxygen-18, the oxygen gas evolved by the plant also contains this isotope. This demonstrates that the oxygen byproduct originates from the photolysis of water molecules rather than from the carbon dioxide fixed during the dark reaction.

100. (2) ribulose 1, 5-diphosphate (RuDP)
In the Calvin cycle, which is the standard pathway for carbon fixation in C_3 plants, the process begins with the incorporation of carbon dioxide. The specific molecule that serves as the primary acceptor for this gas is ribulose-1,5-bisphosphate, commonly known as RuDP. This enzymatic reaction is facilitated by RuBisCO and marks the start of the organic molecule synthesis phase in plants.

101. (4) Maize/corn
C_4 plants are distinguished by their ability to perform efficient photosynthesis under conditions of high temperature and low carbon dioxide. Maize, also known as corn, is a prominent example of a crop that utilizes this specialized pathway. These plants possess a unique leaf anatomy that allows them to minimize photorespiration and maximize biomass production, making them highly productive in warmer climates.

102. (3) all oxygen liberating autotrophs
Chlorophyll a is the essential primary pigment for photosynthesis in a wide variety of organisms. It is found in all autotrophs that perform oxygenic photosynthesis, including higher plants, algae, and cyanobacteria. Because these organisms split water and release oxygen as a byproduct, chlorophyll a is a universal component of their light-harvesting systems, enabling the conversion of solar energy into chemical energy.

103. (3) grana
The thylakoid membrane system within chloroplasts is organized into two distinct regions: the stacked grana and the unstacked stroma lamellae. Photosystem II is primarily located within the appressed regions of the grana thylakoids. This localization is essential for its function in capturing light energy and splitting water molecules, while photosystem I is found in both the grana and stroma lamellae.

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66. (3) Twelve
To produce one molecule of glucose, C_3 plants require eighteen ATP molecules. In contrast, C_4 plants require thirty ATP molecules because each molecule of carbon dioxide fixed costs two additional ATP during the regeneration of phosphoenolpyruvate. Therefore, C_4 plants consume twelve more ATP molecules than C_3 plants to synthesize a single molecule of hexose sugar, reflecting the higher energetic cost.

67. (4) the primary fixation of CO_2 is mediated via PEP carboxylase.
Photosynthesis in C_4 plants is less affected by low atmospheric carbon dioxide levels because they possess a highly efficient initial fixation enzyme. PEP carboxylase, located in the mesophyll cells, has a much higher affinity for carbon dioxide than RuBisCO. This allows the plant to effectively capture carbon even when stomata are partially closed, ensuring a steady supply for the Calvin cycle.

68. (3) 3-phosphoglyceric acid
In plants following the C_3 pathway, the dark reaction begins when carbon dioxide is fixed to a five-carbon sugar. This reaction produces an unstable six-carbon intermediate that immediately splits into two molecules of 3-phosphoglyceric acid. As a three-carbon compound, it is identified as the first stable product of the Calvin cycle, which gives the pathway its distinctive scientific name.

69. (1) larger photosynthetic unit size than the sun plants
Shade-tolerant plants, which are adapted to environments with low light intensity, possess several distinct physiological characteristics compared to sun-loving plants. They often have larger photosynthetic unit sizes, meaning they contain more pigment molecules per reaction center. This adaptation enables them to capture and process limited photons more efficiently, allowing for a sustainable rate of photosynthesis even under heavily shaded conditions.

70. (4) Violet and blue
Carotenoids are accessory pigments found in the chloroplasts of higher plants that help broaden the range of light used for photosynthesis. They primarily absorb light energy in the violet and blue regions of the visible spectrum. By capturing these wavelengths and transferring the energy to chlorophyll a, they enhance light-harvesting efficiency and also protect the plant from potential photo-oxidative damage.

71. (2) Magnesium
The chlorophyll molecule has a complex structure consisting of a porphyrin head and a long phytol tail. At the very center of the porphyrin ring, a single atom of magnesium is coordinated. This metal ion is essential for the pigment's ability to absorb light energy effectively. Without magnesium, the molecule cannot function in capturing photons during the process of photosynthesis.

72. (2) ADP + Inorganic PO_4 (Light energy) → ATP
Photophosphorylation is a fundamental biological process that converts light energy into chemical energy. It specifically involves the addition of an inorganic phosphate group to adenosine diphosphate to form adenosine triphosphate. This reaction is driven by the energy derived from absorbed photons during the light-dependent stage of photosynthesis. This process is essential for providing the energy needed for subsequent sugar synthesis.

73. (2) phosphoenol pyruvic acid carboxylase
Sugarcane is a C_4 plant that utilizes a specific enzyme for the initial capture of atmospheric carbon dioxide. This enzyme, known as phosphoenolpyruvate carboxylase, catalyzes the reaction between carbon dioxide and phosphoenolpyruvate in the mesophyll cells. This process results in the formation of malic acid via an oxaloacetic acid intermediate, allowing the plant to concentrate carbon for the Calvin cycle.

74. (3) open during the night and close during the day
CAM plants exhibit a unique stomatal behavior as an adaptation to arid environments. Their stomata remain closed during the day to prevent excessive water loss through transpiration when temperatures are high. Instead, they open at night when it is cooler to take in carbon dioxide. This absorbed carbon is stored as organic acids and utilized during the following daylight period.

75. (3) It is a characteristic of C_4 plants.
Photorespiration is a metabolic process that occurs in C_3 plants when oxygen concentrations are high and carbon dioxide levels are low. It involves the organelles chloroplast, peroxisome,

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the thylakoid membrane. It consists of a flat, light-absorbing porphyrin head and a long, hydrophobic phytol tail. The dimensions of this molecule are approximately fifteen by fifteen Angstroms for the head and twenty Angstroms for the tail. This structure is essential for its biological function.

114. (1) stroma of bundle sheath chloroplasts
In C_4 plants, the photosynthetic process is spatially separated between two types of cells to increase efficiency. While the initial carbon fixation occurs in the mesophyll cells, the actual Calvin cycle takes place in the bundle sheath cells. Specifically, the enzymes required for the cycle, including RuBisCO, are located within the stroma of the chloroplasts found in these specialized cells.

115. (2) glycolate
Photorespiration begins when the enzyme RuBisCO acts as an oxygenase, leading to the formation of phosphoglycolate in the chloroplast. This two-carbon compound is quickly converted into glycolate. Glycolate then serves as the primary substrate that leaves the chloroplast and enters the peroxisome to continue the pathway. This series of reactions is a characteristic feature of carbon recovery in C_3 plants.

116. (4) non-cyclic photophosphorylation.
The reduction of NADP to NADPH occurs during the non-cyclic photophosphorylation pathway of the light reactions. In this process, electrons flow from water through photosystem II and photosystem I to reach the final acceptor. The enzyme NADP reductase then catalyzes the transfer of these electrons to NADP. This reduced molecule is essential for providing the hydrogen needed for organic synthesis.

117. (4) dark reaction.
Carbon dioxide is an essential raw material for photosynthesis, but it does not participate in the initial light-harvesting phase. Instead, it enters the photosynthetic pathway during the dark reaction, also known as the Calvin cycle. This stage occurs in the stroma of the chloroplast, where the gas is fixed into organic molecules using the energy stored in ATP and NADPH.

118. (4) A-III, B-I, C-II, D-IV
Photosynthetic pigments are identified by their specific colors when separated during chromatography. Chlorophyll a is blue-green, while chlorophyll b is yellow-green. Xanthophylls are typically yellow, and carotenoids range from yellow to yellow-orange. These various pigments allow plants to absorb light across a broader spectrum, maximizing the efficiency of energy capture during the light-dependent reactions of the photosynthetic process.

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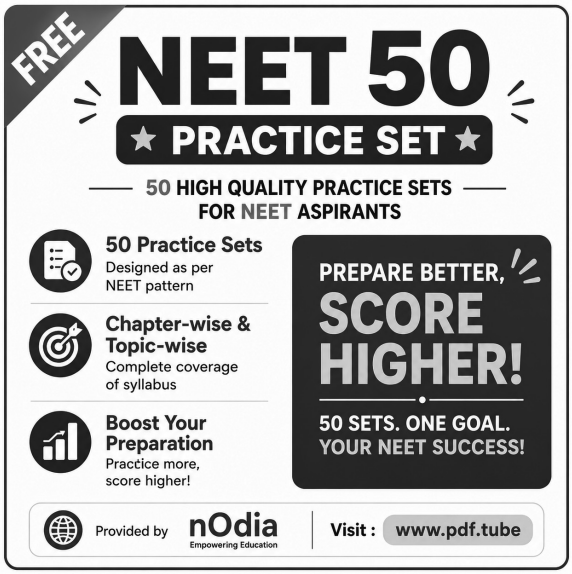

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1999

41. Net gain of ATP molecules, during aerobic respiration, is
(1) 40 molecules
(2) 48 molecules
(3) 36 molecules
(4) 38 molecules.

1998

42. Which one of the following statements about cytochrome P450 is wrong?
(1) It is a coloured cell.
(2) It is an enzyme involved in oxidation reactions.
(3) It has an important role in metabolism.
(4) It contains iron.

1997

43. The end product of fermentation are
(1) O_2 and C_2H_5OH
(2) CO_2 and acetaldehyde
(3) CO_2 and O_2
(4) CO_2 and C_2H_5OH.

1997

44. Which of the following is the key intermediate compound linking glycolysis to the Krebs' cycle?
(1) Malic acid
(2) Acetyl CoA
(3) NADH
(4) ATP

1997

45. In Krebs' cycle, the FAD precipitates as electron acceptor during the conversion of
(1) fumaric acid to malic acid
(2) succinic acid to fumaric acid
(3) succinyl CoA to succinic acid
(4) α-ketoglutarate to succinyl CoA.

1997

46. The correct sequence of electron acceptor in ATP synthesis is
(1) Cyt. b, c, a_3, a
(2) Cyt. c, b, a, a_3
(3) Cyt. a, a, b, c
(4) Cyt. b, c, a, a_3.

1996

47. At the end of glycolysis, six carbon compound ultimately changes into
(1) ethyl alcohol
(2) acetyl Co-A
(3) pyruvic acid
(4) ATP.

1996

48. Which of the following products are obtained by anaerobic respiration from yeast?
(1) Beer and wine
(2) Alcohols
(3) CO_2
(4) All of these

1996

49. When one molecule of ATP is disintegrated, what amount of energy is liberated?
(1) 8 kcal (2) 38 kcal
(3) 7 kcal (4) 4.5 kcal

1994

50. The first phase in the breakdown of glucose, in animal cell, is
(1) fermentation
(2) Krebs' cycle
(3) glycolysis
(4) ETS.

1994

51. When yeast ferments glucose, the products obtained are
(1) ethanol and CO_2
(2) methanol and CO_2
(3) ethanol and water
(4) water and CO_2.

1994

52. The 1992 Nobel Prize for medicine was awarded to Edmond H. Fischer and Edwin J. Krebs for their work concerning
(1) reversible protein phosphorylation as a biological regulation mechanism
(2) isolation of the gene for a human disease
(3) human genome project
(4) drug designing involving inhibition of DNA synthesis of the pathogen.

1994

53. The ultimate respiratory substrate, yielding maximum number of ATP molecules, is
(1) glycogen
(2) ketogenic amino acid
(3) glucose
(4) amylose.

1994

54. Plants, but not animals, can convert fatty acids to sugars by a series of reactions called
(1) photosynthesis
(2) Kreb's cycle
(3) glycolysis
(4) glyoxylate cycle.

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2024

7. Match List I with List II.

List I (Processes/ Components)			List II (Locations)
A.	Citric acid cycle	I.	Cytoplasm
B.	Glycolysis	II.	Mitochondrial matrix
C.	Electron transport system	III.	Intermembrane space of mitochondria
D.	Proton gradient	IV.	Inner mitochondrial membrane

Choose the correct answer from the options given below.
(1) A-I, B-II, C-III, D-IV
(2) A-II, B-I, C-IV, D-III
(3) A-III, B-IV, C-I, D-II
(4) A-IV, B-III, C-II, D-I

2024

8. Identify the step in tricarboxylic acid cycle, which does not involve oxidation of substrate.
(1) Malic acid → Oxaloacetic acid
(2) Succinic acid → Malic acid
(3) Succinyl-CoA → Succinic acid
(4) Isocitrate → α-ketoglutaric acid

2023

9. Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R) :
Assertion (A) : ATP is used at two steps in glycolysis.
Reason (R) : First ATP is used in converting glucose into glucose-6-phosphate and second ATP is used in conversion of fructose-6-phosphate into fructose-1-6-diphosphate.
In the light of the above statements, choose the correct answer from the options given below:
(1) (A) is true but (R) is false.
(2) (A) is false but (R) is true.
(3) Both (A) and (R) are true and (R) is the correct explanation of (A).
(4) Both (A) and (R) are true but (R) is not the correct explanation of (A).

Manipur NEET 2023

10. How many times decarboxylation occurs during each TCA cycle?
(1) Thrice (2) Many
(3) Once (4) Twice

2023

11. Match List I with List II :

List I (Processes)		List II (Enzymes/Pathways)	
A.	Oxidative decarboxylation	I.	Citrate synthase
B.	Glycolysis	II.	Pyruvate dehydrogenase
C.	Oxidative phosphorylation	III.	Electron transport system
D.	Tricarboxylic acid cycle	IV.	EMP pathway

Choose the correct answer from the options given below:
(1) A-III, B-I, C-II, D-IV
(2) A-II, B-IV, C-III, D-I
(3) A-III, B-IV, C-II, D-I
(4) A-II, B-IV, C-I, D-III

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Manipur NEET 2023

12. Fatty acids are connected with the respiratory pathway through
(1) acetyl CoA
(2) α-Ketoglutaric acid
(3) di-hydroxy acetone phosphate
(4) pyruvic acid.

2022

13. What amount of energy is released from glucose during lactic acid fermentation?
(1) Approximately 15%
(2) More than 18%
(3) About 10%
(4) Less than 7%

2022

14. What is the net gain of ATP when each molecule of glucose is converted to two molecules of pyruvic acid?
(1) Four (2) Six
(3) Two (4) Eight

2021

15. Which of the following statements is incorrect?
(1) Oxidation-reduction reactions produce proton gradient in respiration.
(2) During aerobic respiration, role of oxygen is limited to the terminal stage.
(3) In ETC (Electron Transport Chain), one molecule of NADH + H^+ gives rise to 2 ATP molecules, and one $FADH_2$ gives rise to 3 ATP molecules.
(4) ATP is synthesised through complex V.

0.7, which is characteristic of lipids being used as a substrate.

20. (2) It functions as an electron carrier.
Nicotinamide adenine dinucleotide acts as a vital coenzyme in cellular respiration. Its primary function is to serve as an electron carrier during various redox reactions. It accepts electrons and protons during the oxidation of organic molecules in glycolysis and the Krebs cycle, becoming reduced to NADH. These electrons are then delivered to the electron transport chain to facilitate efficient ATP production.

21. (4) Oxidative phosphorylation takes place in outer mitochondrial membrane.
Cellular respiration involves specific compartmentalized reactions. Glycolysis takes place in the cytosol, while the enzymes for the tricarboxylic acid cycle are located in the mitochondrial matrix. However, oxidative phosphorylation, which involves the electron transport chain and ATP synthase, occurs on the inner mitochondrial membrane. Stating that this process takes place in the outer mitochondrial membrane is an inaccurate description.

22. (3) The cycle starts with condensation of acetyl group (acetyl CoA) with pyruvic acid to yield citric acid.
The Krebs cycle begins when the two-carbon acetyl group from acetyl CoA condenses with the four-carbon oxaloacetic acid to form the six-carbon citric acid. Stating that the cycle starts with the condensation of acetyl CoA with pyruvic acid is incorrect, as pyruvic acid must first undergo oxidative decarboxylation to become acetyl CoA before it can enter the cycle.

23. (4) formation of ATP by energy released from electrons removed during substrate oxidation.
Oxidative phosphorylation is the final stage of aerobic respiration where ATP is produced. It utilizes the energy released from the transfer of electrons through the electron transport chain. These electrons are removed from substrates during previous oxidative steps. The energy is used to pump protons, creating a gradient that drives ATP synthesis as protons flow back through the ATP synthase complex.

24. (4) Acetyl CoA
Different respiratory substrates follow various pathways before entering the central metabolic route. Carbohydrates are converted to glucose, fats are broken down into glycerol and fatty acids, and proteins into amino acids. All these molecules are eventually converted into acetyl CoA. This two-carbon compound serves as the universal intermediate that enters the tricarboxylic acid cycle for complete oxidation and energy release.

25. (1) cristae of mitochondria
Cytochromes are specialized heme-containing proteins that function as electron carriers in the mitochondrial electron transport chain. They are located within the inner mitochondrial membrane, specifically on the folds known as cristae. This arrangement facilitates the efficient transfer of electrons between complexes, which is essential for establishing the proton gradient necessary for ATP synthesis during the final stages of aerobic respiration.

26. (4) Lactate fermentation
Carbon dioxide is a common byproduct of both aerobic respiration and alcoholic fermentation. In aerobic processes, decarboxylation occurs in the matrix. During alcoholic fermentation in yeast, pyruvate is decarboxylated to acetaldehyde, releasing CO_2. However, in lactate fermentation, which occurs in certain bacteria and oxygen-deprived muscle cells, pyruvate is directly reduced to lactic acid without the loss of any carbon atoms.

27. (4) ATP.
In diagrams illustrating the three major pathways of aerobic respiration—glycolysis, the citric acid cycle, and the electron transport system—certain products are common to all. Arrows representing the net output of these stages often indicate energy carriers. Specifically, ATP is synthesized during all three phases, either through substrate-level phosphorylation in the first two stages or through oxidative phosphorylation.

28. (2) Acetyl CoA
The metabolism of carbohydrates, fats, and proteins converges at a specific intermediate. Carbohydrates enter the glycolytic pathway, while fats and proteins are broken down into components that eventually form acetyl CoA. This two-carbon molecule acts as the primary entry point for the tricarboxylic acid cycle, regardless of the initial substrate used, making

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2013

28. Which of the metabolites is common to respiration-mediated breakdown of fats, carbohydrates and proteins?
(1) Pyruvic acid
(2) Acetyl CoA
(3) Glucose - 6 - phosphate
(4) Fructose 1, 6 - bisphosphate

Mains 2011

29. In mitochondria, protons accumulate in the
(1) outer membrane
(2) inner membrane
(3) intermembrane space
(4) matrix.

2010, 2008

30. The energy-releasing metabolic process in which substrate is oxidised without an external electron acceptor is called
(1) glycolysis
(2) fermentation
(3) aerobic respiration
(4) photorespiration.

2009

31. Aerobic respiratory pathway is appropriately termed
(1) parabolic
(2) amphibolic
(3) anabolic
(4) catabolic.

2007

32. All enzymes of TCA cycle are located in the mitochondrial matrix except one which is located in inner mitochondrial membranes in eukaryotes and in cytosol in prokaryotes. This enzyme is
(1) isocitrate dehydrogenase
(2) malate dehydrogenase
(3) succinate dehydrogenase
(4) lactate dehydrogenase.

2007

33. The overall goal of glycolysis, Krebs' cycle and the electron transport system is the formation of
(1) ATP in one large oxidation reaction
(2) sugars
(3) nucleic acids
(4) ATP in small stepwise units.

2006

34. How many ATP molecules could maximally be generated from one molecule of glucose, if the complete oxidation of one mole of glucose to CO_2 and H_2O yields 686 kcal and the useful chemical energy available in the high energy phosphate bond of one mole of ATP is 12 kcal?
(1) 1
(2) 2
(3) 30
(4) 57

2005

35. During which stage in the complete oxidation of glucose are the greatest number of ATP molecules formed from ADP?
(1) Glycolysis
(2) Krebs' cycle
(3) Conversion of pyruvic acid to acetyl CoA
(4) Electron transport chain

2004

36. In glycolysis, during oxidation electrons are removed by
(1) ATP
(2) glyceraldehyde-3-phosphate
(3) NAD^+
(4) molecular oxygen.

2003

37. In alcohol fermentation
(1) triose phosphate is the electron donor while acetaldehyde is the electron acceptor
(2) triose phosphate is the electron donor while pyruvic acid is the electron acceptor
(3) there is no electron donor
(4) oxygen is the electron acceptor.

2003

38. In which one of the following do the two names refer to one and the same thing ?
(1) Krebs' cycle and Calvin cycle
(2) Tricarboxylic acid cycle and citric acid cycle
(3) Citric acid cycle and Calvin cycle
(4) Tricarboxylic acid cycle and urea cycle

2002

39. How many ATP molecules are produced by aerobic oxidation of one molecule of glucose?
(1) 2
(2) 4
(3) 38
(4) 34

2001

40. Cytochrome is
(1) metallo flavo protein
(2) Fe containing porphyrin pigment
(3) glycoprotein
(4) lipid.

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ANSWERS

1. (2) 412
During glycolysis, one molecule of glucose is broken down into two molecules of pyruvic acid. Therefore, 206 molecules of glucose yield 206 × 2 = 412 molecules of pyruvic acid.

2. (1) Between 0.5 and 0.95
RQ = volume of CO_2 released / volume of O_2 consumed = 102 / 145 = 0.7 (approximately). This value lies between 0.5 and 0.95, which is typical for fats. The molecule given is a fatty substance, so its respiratory quotient is less than one.

3. (3) A-III, B-I, C-IV, D-II
Glycolysis occurs in the cytoplasm. The electron transport system (ETS) is located on the inner mitochondrial membrane. Protons accumulate in the intermembrane space during chemiosmosis. The Krebs' cycle takes place in the mitochondrial matrix. This gives the match A-III, B-I, C-IV, D-II.

4. (4) Succinate dehydrogenase.
Succinate dehydrogenase is an essential enzyme of both the mitochondrial electron transport chain and the citric acid cycle. It catalyzes the oxidation of succinate to fumarate while simultaneously reducing FAD to $FADH_2$. It acts as Complex II, transferring electrons to the ubiquinone pool. Unlike other complexes in the chain, it does not pump protons across the mitochondrial membrane.

5. (2) A-I, B-IV, C-II, D-III
The mitochondrial electron transport chain consists of four primary protein complexes located within the inner membrane. Complex I is NADH dehydrogenase, which initiates electron transfer. Complex II involves succinate dehydrogenase. Complex III consists of the cytochrome bc1 complex, while Complex IV is cytochrome c oxidase, where oxygen serves as the final electron acceptor. These complexes facilitate the established proton gradient.

6. (1) A, C, D, E only
Cellular respiration involves breaking carbon-carbon bonds through oxidation to release energy. While glycolysis occurs in the cytoplasm, the subsequent stages take place in the mitochondria. In germinating seeds, fermentation occurs under anaerobic conditions. The fate of pyruvate varies by organism, and oxygen serves as the terminal electron acceptor, eventually forming water as a result of accepting electrons and being reduced.

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7. (2) A-II, B-I, C-IV, D-III
Cellular respiration occurs in distinct compartments within the cell. Glycolysis takes place in the cytoplasm, converting glucose to pyruvate. The citric acid cycle occurs within the mitochondrial matrix. The electron transport system is localized in the inner mitochondrial membrane, while the resulting proton gradient is established across the intermembrane space of the mitochondria to drive the synthesis of ATP molecules.

8. (3) Succinyl-CoA → Succinic acid
In the tricarboxylic acid cycle, most steps involve the oxidation of substrates coupled with the reduction of electron carriers like NAD^+ or FAD. However, the conversion of succinyl-CoA to succinic acid is a substrate-level phosphorylation step. This specific reaction generates a molecule of GTP or ATP directly without involving the removal of electrons from the substrate through an oxidation process.

9. (3) Both (A) and (R) are true and (R) is the correct explanation of (A).
Glycolysis initiates with the phosphorylation of glucose, which requires an initial energy input. The first ATP molecule is utilized by hexokinase to convert glucose into glucose-6-phosphate. A second ATP molecule is consumed during the conversion of fructose-6-phosphate into fructose-1,6-bisphosphate by phosphofructokinase. These preparatory steps ensure the sugar is activated for subsequent cleavage and energy extraction during the metabolic process.

10. (4) Twice
During a single turn of the tricarboxylic acid cycle, carbon dioxide is released at two specific stages. The first decarboxylation occurs when isocitrate is converted into alpha-ketoglutarate.

1993

55. End product of citric acid cycle/Krebs' cycle is
(1) citric acid
(2) lactic acid
(3) pyruvic acid
(4) $CO_2 + H_2O$.

1993

56. Out of 38 ATP molecules produced per glucose, 32 ATP molecules are formed from NADH/ $FADH_2$ in
(1) respiratory chain
(2) Krebs' cycle
(3) oxidative decarboxylation
(4) EMP.

1992

57. Oxidative phosphorylation is production of
(1) ATP in photosynthesis
(2) NADPH in photosynthesis
(3) ATP in respiration
(4) NADH in respiration.

1992

58. End products of aerobic respiration are
(1) sugar and oxygen
(2) water and energy
(3) carbon dioxide, water and energy
(4) carbon dioxide and energy.

1992

59. Terminal cytochrome of respiratory chain which donates electrons to oxygen is
(1) Cyt b
(2) Cyt c
(3) Cyt a_1
(4) Cyt a_3.

1992

60. When one glucose molecule is completely oxidised, it changes
(1) 36 ADP molecules into 36 ATP molecules
(2) 38 ADP molecules into 38 ATP molecules
(3) 30 ADP molecules into 30 ATP molecules
(4) 32 ADP molecules into 32 ATP molecules.

1992

61. Out of 36 ATP molecules produced per glucose molecule during respiration
(1) 2 are produced outside glycolysis and 34 during respiratory chain
(2) 2 are produced outside mitochondria and 34 inside mitochondria
(3) 2 during glycolysis and 34 during Krebs' cycle
(4) all are formed inside mitochondria.

1992

62. Link between glycolysis, Krebs' cycle and β-oxidation of fatty acid or carbohydrate and fat metabolism is
(1) oxaloacetic acid
(2) succinic acid
(3) citric acid
(4) acetyl CoA.

1992

63. Apparatus to measure rate of respiration and R.Q. is
(1) auxanometer
(2) potometer
(3) respirometer
(4) manometer.

1990

64. End product of glycolysis is
(1) acetyl CoA
(2) pyruvic acid
(3) glucose 1-phosphate
(4) fructose 1-phosphate.

1990

65. Connecting link between glycolysis and Krebs' cycle before pyruvate entering Krebs' cycle is changed to
(1) oxaloacetate (2) PEP
(3) pyruvate (4) acetyl CoA.

1990

66. EMP can produce a total of
(1) 6 ATP (2) 8 ATP
(3) 24 ATP (4) 38 ATP.

1990

67. R.Q. is ratio of
(1) CO_2 produced to substrate consumed
(2) CO_2 produced to O_2 consumed
(3) oxygen consumed to water produced
(4) oxygen consumed to CO_2 produced.

1988

68. NADP+ is reduced to NADPH in
(1) HMP (2) Calvin Cycle
(3) glycolysis (4) EMP.

1988

69. R.Q. is
(1) C/N (2) N/C
(3) CO_2/O_2 (4) O_2/CO_2.

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CHAPTER 12
Respiration in Plants

NODIA

2026 (RE-NEET)

1. How many molecules of pyruvic acid are produced at the end of glycolysis from 206 molecules of glucose?
(1) 103
(2) 412
(3) 206
(4) 309

2026 (CANCELLED)

2. 2 ($C_{51}H_{98}O_6$) + 145 O_2 → 102 CO_2 + 98 H_2O + energy.
The Respiratory Quotient (RQ) of a biomolecule used for respiration, as per the above equation, would be:
(1) Between 0.5 and 0.95
(2) Less than 0.5
(3) 1.0
(4) Between 1.25 and 2

2026 (CANCELLED)

3. Match List I with List II:
List I (Process):
A. Glycolysis
B. ETS
C. Accumulation of protons
D. Krebs' cycle
List II (Location):
I. Inner mitochondrial membrane
II. Mitochondrial matrix
III. Cytoplasm
IV. Intermembrane space
(1) A-IV, B-II, C-I, D-III
(2) A-II, B-III, C-IV, D-I
(3) A-III, B-I, C-IV, D-II
(4) A-I, B-IV, C-III, D-II

2025

4. The complex II of mitochondrial electron transport chain is also known as
(1) Cytochrome c oxidase
(2) NADH dehydrogenase
(3) Cytochrome bc1
(4) Succinate dehydrogenase.

RE-EXAM 2024

5. Match List-I with List-II.

List-I (ETS Complexes)		List-II (Associated Enzymes)	
A.	ETS Complex I	I.	NADH dehydrogenase
B.	ETS Complex II	II.	Cytochrome bc1
C.	ETS Complex III	III.	Cytochrome c oxidase
D.	ETS Complex IV	IV.	Succinate dehydrogenase

Choose the correct answer from the options given below.
(1) A-IV, B-I, C-III, D-II
(2) A-I, B-IV, C-II, D-III
(3) A-III, B-I, C-IV, D-II
(4) A-I, B-II, C-IV, D-III

RE-EXAM 2024

6. Which of the following are correct about cellular respiration?
A. Cellular respiration is the breaking of C - C bonds of complex organic molecules by oxidation.
B. The entire cellular respiration takes place in mitochondria.
C. Fermentation takes place under anaerobic condition in germinating seeds.
D. The fate of pyruvate formed during glycolysis depends on the type of organism also.
E. Water is formed during respiration as a result of O_2 accepting electrons and getting reduced.
Choose the correct answer from the options given below.
(1) A, C, D, E only
(2) A, B, E only
(3) A, B, C, E only
(4) B, C, D, E only

The second occurs during the transformation of alpha-ketoglutarate into succinyl-CoA. These steps are critical for reducing the carbon chain length and generating reduced NADH through these two successive oxidative decarboxylation reactions in the matrix.

11. (2) A-II, B-IV, C-III, D-I
Cellular respiration involves several integrated pathways and enzymes. Glycolysis is also known as the EMP pathway and occurs in the cytoplasm. Pyruvate dehydrogenase facilitates oxidative decarboxylation before the TCA cycle. The TCA cycle begins with citrate synthase in the matrix. Oxidative phosphorylation occurs through the electron transport system, where energy from electrons is used to synthesize ATP molecules in the mitochondria.

12. (1) acetyl CoA
Fatty acids undergo a process called beta-oxidation to enter the respiratory pathway. During this breakdown, they are converted into acetyl CoA, which then enters the tricarboxylic acid cycle in the mitochondrial matrix. This allows fats to serve as an efficient energy source, integrating with carbohydrate metabolism at the point where the two-carbon acetyl group is oxidized for ATP production.

13. (4) Less than 7%
Lactic acid fermentation is an anaerobic process that occurs when oxygen is limited. During this pathway, glucose is partially oxidized to form lactate. Only a small fraction of the total chemical energy stored in glucose is captured in the form of ATP. Specifically, less than seven percent of the energy available in glucose is released during this specific metabolic process.

14. (3) Two
Glycolysis is the initial stage of glucose metabolism occurring in the cytosol. Although four ATP molecules are produced through substrate-level phosphorylation, two ATP molecules are consumed during the initial activation steps. Consequently, the conversion of one glucose molecule into two molecules of pyruvic acid results in a net gain of exactly two ATP molecules for the cell to use.

15. (3) In ETC (Electron Transport Chain), one molecule of NADH + H^+ gives rise to 2 ATP molecules, and one $FADH_2$ gives rise to 3 ATP molecules.
The electron transport chain utilizes redox reactions to establish a proton gradient across the inner mitochondrial membrane. ATP synthesis occurs through complex V using this gradient. In the standard respiratory model, one molecule of NADH typically generates three molecules of ATP, while one molecule of $FADH_2$ produces two. Therefore, describing NADH as yielding two and $FADH_2$ as yielding three is incorrect.

16. (2) one
Substrate-level phosphorylation refers to the direct synthesis of ATP or GTP from ADP or GDP using energy from a metabolic intermediate. In one complete turn of the citric acid cycle, this occurs exactly once. This specific reaction involves the conversion of succinyl CoA to succinic acid, which provides enough energy to couple a phosphate group to a guanosine diphosphate molecule.

17. (3) hexokinase
The first step of glycolysis is the phosphorylation of glucose to form glucose-6-phosphate. This reaction is irreversible under physiological conditions and is catalyzed by the enzyme hexokinase. By adding a phosphate group, the enzyme traps the glucose molecule within the cell and activates it for further metabolic processing. This step requires the consumption of one molecule of adenosine triphosphate energy.

18. (3) Inner mitochondrial membrane
In plant cells, the electron transport system is a series of protein complexes and electron carriers essential for aerobic respiration. These components are embedded within the inner mitochondrial membrane. This location is critical because it allows for the creation of a proton gradient between the mitochondrial matrix and the intermembrane space, which ultimately drives the synthesis of ATP through chemiosmotic mechanisms.

19. (3) 0.7
The respiratory quotient is the ratio of the volume of carbon dioxide evolved to the volume of oxygen consumed during respiration. For fats like tripalmitin, the oxidation process requires a significantly higher amount of oxygen relative to the carbon dioxide released. For this specific triglyceride, the calculated value is approximately

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2020

16. The number of substrate level phosphorylations in one turn of citric acid cycle is
(1) zero
(2) one
(3) two
(4) three.

2019

17. Conversion of glucose to glucose-6-phosphate, the first irreversible reaction of glycolysis, is catalysed by
(1) phosphofructokinase
(2) aldolase
(3) hexokinase
(4) enolase.

Odisha NEET 2019

18. Where is respiratory electron transport system (ETS) located in plants ?
(1) Mitochondrial matrix
(2) Outer mitochondrial membrane
(3) Inner mitochondrial membrane
(4) Intermembrane space

2019

19. Respiratory Quotient (RQ) value of tripalmitin is
(1) 0.09
(2) 0.9
(3) 0.7
(4) 0.07.

2018

20. What is the role of NAD^+ in cellular respiration?
(1) It functions as an enzyme.
(2) It functions as an electron carrier.
(3) It is a nucleotide source for ATP synthesis.
(4) It is the final electron acceptor for anaerobic respiration.

2018

21. Which of these statements is incorrect?
(1) Enzymes of TCA cycle are present in mitochondrial matrix.
(2) Glycolysis occurs in cytosol.
(3) Glycolysis operates as long as it is supplied with NAD that can pick up hydrogen atoms.
(4) Oxidative phosphorylation takes place in outer mitochondrial membrane.

2017

22. Which statement is wrong for Krebs' cycle?
(1) There is one point in the cycle where FAD^+ is reduced to $FADH_2$.
(2) During conversion of succinyl CoA to succinic acid, a molecule of GTP is synthesised.
(3) The cycle starts with condensation of acetyl group (acetyl CoA) with pyruvic acid to yield citric acid.
(4) There are three points in the cycle where NAD^+ is reduced to $NADH + H^+$.

NEET-II 2016

23. Oxidative phosphorylation is
(1) formation of ATP by transfer of phosphate group from a substrate to ADP
(2) oxidation of phosphate group in ATP
(3) addition of phosphate group to ATP
(4) formation of ATP by energy released from electrons removed during substrate oxidation.

NEET-II 2016

24. Which of the following biomolecules is common to respiration-mediated breakdown of fats, carbohydrates and proteins?
(1) Glucose-6-phosphate
(2) Fructose 1, 6-bisphosphate
(3) Pyruvic acid
(4) Acetyl CoA

2015 Cancelled

25. Cytochromes are found in
(1) cristae of mitochondria
(2) lysosomes
(3) matrix of mitochondria
(4) outer wall of mitochondria.

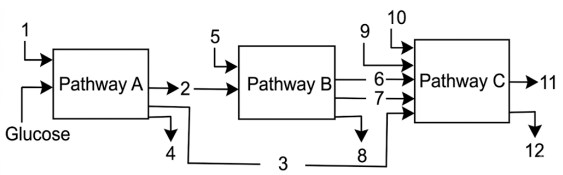
2014

26. In which one of the following processes CO_2 is not released?
(1) Aerobic respiration in plants
(2) Aerobic respiration in animals
(3) Alcoholic fermentation
(4) Lactate fermentation

NODIA

2013

27. The three boxes in this diagram represent the three major biosynthetic pathways in aerobic respiration. Arrows represent net reactants or products.
Arrows numbered 4, 8 and 12 can all be



(1) H_2O
(2) FAD^+ or $FADH_2$
(3) NADH
(4) ATP.

it the most common metabolite in respiratory breakdown.

29. (3) intermembrane space
During the process of oxidative phosphorylation, electrons are passed through the transport chain located in the inner mitochondrial membrane. The energy released during these redox reactions is used to pump protons from the mitochondrial matrix into the intermembrane space. This creates a high concentration of protons, establishing an electrochemical gradient that subsequently drives ATP synthesis as they flow back.

30. (2) fermentation
Fermentation is an anaerobic metabolic process where energy is extracted from organic substrates like glucose. Unlike aerobic respiration, it does not require an external electron acceptor such as oxygen. Instead, the electrons removed are transferred to internal organic intermediates like pyruvate. This allows for the regeneration of NAD^+ and a limited production of ATP through substrate-level phosphorylation without external acceptors.

31. (2) amphibolic
The respiratory pathway is traditionally considered catabolic because it involves the breakdown of complex molecules to release energy. However, many intermediates from the pathway are withdrawn to synthesize various other biomolecules, such as amino acids or fatty acids. Because the pathway involves both the breakdown of substrates and the synthesis of new compounds, it is more accurately described as amphibolic.

32. (3) succinate dehydrogenase.
Most enzymes of the tricarboxylic acid cycle are soluble and found within the mitochondrial matrix. Succinate dehydrogenase is a unique exception because it is physically bound to the inner mitochondrial membrane in eukaryotes. It functions simultaneously in the Krebs cycle by oxidizing succinate to fumarate and in the electron transport chain as Complex II, where it facilitates the transfer of electrons.

33. (4) ATP in small stepwise units.
The primary objective of glycolysis, the Krebs cycle, and the electron transport system is to extract energy from respiratory substrates efficiently. Rather than releasing energy in a single, large explosive reaction, these metabolic pathways break down molecules in a series of controlled, small steps. This gradual process allows the cell to capture and store energy systematically in many ATP molecules.

34. (4) 57
Determining the maximum number of ATP molecules involves comparing the energy released from complete glucose oxidation to the energy required to form a high-energy phosphate bond. Dividing the total available energy of 686 kilocalories by the 12 kilocalories required per mole of ATP reveals that exactly 57 molecules can be generated during this biological energy conversion process under these conditions.

35. (4) Electron transport chain
Complete oxidation of glucose occurs in stages including glycolysis, the link reaction, and the Krebs cycle. While these steps produce some ATP directly through substrate-level phosphorylation, the majority of the energy is stored in reduced coenzymes. The electron transport chain utilizes these carriers to generate a proton gradient, resulting in the production of the largest number of ATP molecules.

36. (3) NAD^+
During the oxidative phase of glycolysis, specifically when glyceraldehyde-3-phosphate is converted into 1,3-bisphosphoglycerate, electrons are removed from the substrate. These electrons, along with hydrogen ions, are picked up by the coenzyme NAD^+, which acts as an electron acceptor. This reduction process converts NAD^+ into NADH, which then carries high-energy electrons to the electron transport chain for further energy production.

37. (1) triose phosphate is the electron donor while acetaldehyde is the electron acceptor
In the process of alcoholic fermentation, glucose is first converted to triose phosphate, which acts as the electron donor as it is oxidized. This leads to the formation of pyruvate and then acetaldehyde. Acetaldehyde then acts as the final electron acceptor, receiving electrons from NADH to form ethanol. This mechanism allows the regeneration of NAD^+, enabling glycolysis to continue.

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Mains 2010

44. Root development is promoted by
(1) abscisic acid
(2) auxin
(3) gibberellin
(4) ethylene.

2009

45. One of the synthetic auxin is
(1) IAA
(2) GA
(3) IBA
(4) NAA.

2009

46. Which one of the following acids is a derivative of carotenoids?
(1) Indole-3-acetic acid
(2) Gibberellic acid
(3) Abscisic acid
(4) Indole butyric acid

2008

47. Senescence as an active developmental cellular process in the growth and functioning of a flowering plant, is indicated in
(1) annual plants
(2) floral parts
(3) vessels and tracheid differentiation
(4) leaf abscission.

2007

48. Which one of the following pairs, is not correctly matched?
(1) Gibberellic acid - Leaf fall
(2) Cytokinin - Cell division
(3) IAA - Cell wall elongation
(4) Abscissic acid - Stomatal closure

2006

49. Parthenocarpic tomato fruits can be produced by
(1) treating the plants with phenylmercuric acetate
(2) removing androecium of flowers before pollen grains are released
(3) treating the plants with low concentrations of gibberellic acid and auxins
(4) raising the plants from vernalized seeds.

2006

50. How does pruning help in making the hedge dense?
(1) It releases wound hormones.
(2) It induces the differentiation of new shoots from the rootstock
(3) It frees axillary buds from apical dominance.
(4) The apical shoot grows faster after pruning.

2004

51. Cell elongation in internodal regions of the green plants takes place due to
(1) indole acetic acid
(2) cytokinins
(3) gibberellins
(4) ethylene.

2003

52. Coconut milk factor is
(1) an auxin
(2) a gibberellin
(3) abscisic acid
(4) cytokinin.

2003

53. Plants deficient of element zinc, show its effect on the biosynthesis of plant growth hormone
(1) auxin
(2) cytokinin
(3) ethylene
(4) abscisic acid.

2003

54. Differentiation of shoot is controlled by
(1) high auxin : cytokinin ratio
(2) high cytokinin : auxin ratio
(3) high gibberellin : auxin ratio
(4) high gibberellin : cytokinin ratio.

2002, 1992

55. Dwarfness can be controlled by treating the plant with
(1) cytokinin
(2) gibberellic acid
(3) auxin
(4) anti-gibberellin.

NODIA

2001

56. Which of the following prevents the fall of fruits?
(1) GA_3
(2) NAA
(3) Ethylene
(4) Zeatin

2001

57. Hormone responsible for senescence is
(1) ABA
(2) auxin
(3) GA
(4) cytokinin.

48. (4) All of these
Yeast organisms perform anaerobic respiration, specifically alcoholic fermentation, when oxygen levels are insufficient. This metabolic process utilizes glucose to produce ethanol and carbon dioxide as primary byproducts. These products are foundational in several industries, including the brewing of beer and wine and the production of industrial alcohols. Therefore, ethanol, carbon dioxide, and fermented beverages are all outcomes of this metabolism.

49. (3) 7 kcal
Adenosine triphosphate is the primary energy currency of the cell. When the high-energy terminal phosphate bond of an ATP molecule is broken through hydrolysis, energy is released for cellular work. Under standard physiological conditions, the disintegration of one molecule of ATP into ADP and inorganic phosphate liberates approximately seven kilocalories of useful energy, which the cell utilizes for biological processes.

50. (3) glycolysis
Cellular respiration begins with the breakdown of glucose into smaller organic molecules. In animal cells, the very first stage of this metabolic process is glycolysis, which takes place in the cytoplasm. This sequence of reactions does not require oxygen and serves to partially oxidize glucose into pyruvate, while also generating a small amount of ATP and reduced NADH for later use.

51. (1) ethanol and CO_2
When yeast cells encounter anaerobic conditions, they switch to a metabolic pathway known as alcoholic fermentation to maintain energy production. This process involves the conversion of glucose into pyruvate via glycolysis, followed by the conversion of pyruvate into acetaldehyde and then into ethanol. Carbon dioxide is released as a byproduct during the decarboxylation step, making ethanol and CO_2 end products.

52. (1) reversible protein phosphorylation as a biological regulation mechanism
The 1992 Nobel Prize in Physiology or Medicine was awarded to Edmond Fischer and Edwin Krebs for their pioneering discoveries. Their research focused on reversible protein phosphorylation as a fundamental biological regulatory mechanism. They demonstrated how the addition and removal of phosphate groups can act as a molecular switch to control the activity of enzymes and other proteins in cellular pathways.

53. (3) glucose
While the body can utilize fats, proteins, and various complex carbohydrates for energy, they are ultimately processed into simpler forms to enter the respiratory pathways. Glucose is considered the primary and most direct respiratory substrate for the majority of cells. Its complete oxidation provides a predictable and maximum yield of ATP through the integrated processes of glycolysis and the Krebs cycle.

54. (4) glyoxylate cycle.
Plants possess a unique metabolic pathway that allows them to convert stored fatty acids into carbohydrates, which is especially important during seed germination. This pathway is called the glyoxylate cycle, a variation of the citric acid cycle. It involves specialized organelles called glyoxysomes and enables the synthesis of four-carbon dicarboxylic acids from acetyl CoA, bypassing the decarboxylation steps.

55. (4) $CO_2 + H_2O$.
The tricarboxylic acid cycle represents the final stage of carbon oxidation in aerobic respiration. During this cycle, the two-carbon acetyl group is completely broken down. The carbon atoms are released in the form of carbon dioxide. Furthermore, the hydrogen atoms removed during oxidation eventually combine with oxygen in the electron transport chain to form water, resulting in CO_2 and H_2O.

NODIA

56. (1) respiratory chain
In the complete aerobic oxidation of a single glucose molecule, the majority of the total ATP yield is not produced directly. Instead, high-energy electrons are captured by NADH and $FADH_2$ and then transferred to the respiratory chain, also known as the electron transport system. In this stage, approximately 32 ATP molecules are synthesized through oxidative phosphorylation, driven by the proton gradient.

57. (3) ATP in respiration
Phosphorylation refers to the addition of a phosphate group to a molecule. In the context of cellular metabolism, oxidative phosphorylation specifically describes the synthesis of ATP from ADP and inorganic phosphate during the final

38. (2) Tricarboxylic acid cycle and citric acid cycle
The metabolic pathway that occurs in the mitochondrial matrix to oxidize acetyl CoA is known by several names. It is frequently called the tricarboxylic acid cycle because its first stable product is citric acid, which contains three carboxyl groups. For this reason, it is also interchangeably referred to as the citric acid cycle or the Krebs cycle, after scientist Hans Krebs.

39. (3) 38
Aerobic respiration involves the complete oxidation of glucose through several interconnected stages. This includes glycolysis, the transition reaction, the citric acid cycle, and the electron transport chain. When adding the ATP produced directly by substrate-level phosphorylation to the ATP generated from NADH and $FADH_2$ via oxidative phosphorylation, a total of 38 ATP molecules can theoretically be produced from one glucose.

40. (2) Fe containing porphyrin pigment
Cytochromes are essential protein components of the electron transport chains in both mitochondria and chloroplasts. They are characterized as hemeproteins, meaning they contain a prosthetic group consisting of an iron-containing porphyrin ring. The iron atom within the heme group can exist in either an oxidized or reduced state, allowing the cytochrome to function as an effective electron carrier during redox reactions.

41. (3) 36 molecules
The total yield of ATP during the complete aerobic oxidation of glucose is calculated by summing the products of glycolysis, the Krebs cycle, and the electron transport chain. In many eukaryotic systems, a small amount of energy is expended to transport cytoplasmic NADH into the mitochondria. This typically results in a net gain of 36 ATP molecules per molecule of glucose.

42. (1) It is a coloured cell.
Cytochrome P450 is a large family of enzymes that play a crucial role in the metabolism of various endogenous and exogenous compounds. These enzymes contain iron within a heme group and are involved in oxidation-reduction reactions, particularly in the liver. It is a membrane-bound protein found in the endoplasmic reticulum, and stating that it is a cell is incorrect.

43. (4) CO_2 and C_2H_5OH.
Fermentation is an anaerobic pathway used by organisms like yeast to obtain energy from glucose. After glycolysis, the resulting pyruvate undergoes decarboxylation to produce acetaldehyde, which is then reduced. This two-step process results in the formation of ethanol and carbon dioxide as the primary end products. This pathway is widely utilized in the production of alcoholic beverages and baking.

44. (2) Acetyl CoA
Before the products of glycolysis can enter the citric acid cycle, the three-carbon pyruvate must be converted into a two-carbon molecule. This transition occurs in the mitochondrial matrix through oxidative decarboxylation, catalyzed by the pyruvate dehydrogenase complex. The resulting acetyl CoA serves as the essential linking molecule that connects the cytoplasmic process of glycolysis with the mitochondrial reactions of the Krebs cycle.

45. (2) succinic acid to fumaric acid
Within the tricarboxylic acid cycle, several reactions involve the reduction of electron carriers to store energy. One specific step is the oxidation of succinic acid into fumaric acid. This reaction is catalyzed by succinate dehydrogenase, which uses FAD as an electron acceptor. During this process, FAD is reduced to $FADH_2$, which subsequently delivers its high-energy electrons to the chain.

46. (4) Cyt. b, c, a, a_3.
The electron transport chain consists of various complexes and cytochrome proteins that facilitate the movement of electrons toward oxygen. Electrons typically flow through the complexes in a specific order: starting from complex III which contains cytochrome b and cytochrome c1, then to the mobile carrier cytochrome c, and finally to complex IV, which contains cytochrome a and cytochrome a_3.

47. (3) pyruvic acid
Glycolysis is a metabolic pathway that occurs in the cytoplasm and breaks down a single six-carbon glucose molecule into smaller units. Through a series of ten enzyme-catalyzed reactions, the glucose molecule is split and oxidized. The final product of this process consists of two molecules of the three-carbon compound known as pyruvic acid, which can then enter further stages.

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67. (2) CO_2 produced to O_2 consumed

The respiratory quotient is a dimensionless number used to analyze the efficiency and type of metabolism occurring in an organism. It is defined as the ratio of the volume of carbon dioxide produced during a specific period to the volume of oxygen consumed during the same period. This ratio varies depending on the chemical composition of the respiratory substrate being oxidized.

68. (1) HMP

The hexose monophosphate shunt, also known as the pentose phosphate pathway, is an alternative route for glucose metabolism. Unlike glycolysis, which produces NADH, the primary function of this pathway is to generate NADPH. This reduced coenzyme provides the necessary reducing power for biosynthetic reactions, such as fatty acid synthesis, and helps maintain cellular antioxidant levels by regenerating reduced glutathione.

69. (3) CO_2/O_2

The respiratory quotient represents the relationship between the gases exchanged during cellular respiration. It is calculated by dividing the volume of carbon dioxide evolved by the volume of oxygen absorbed by the organism or tissue. This mathematical ratio is useful in physiology for identifying the primary nutrient source being utilized for energy production, as carbohydrates and fats have distinct values.

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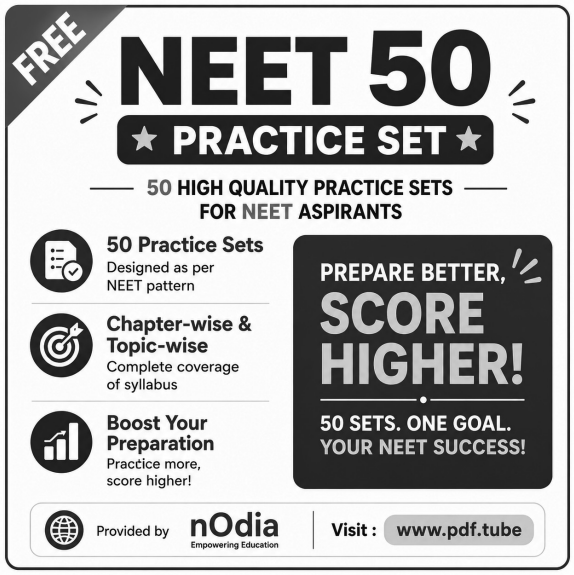

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CHAPTER 13
Plant Growth and Development

2026 (RE-NEET)

1. Length of the stem at time 0 is 20 cm. The arithmetic growth rate is 30 cm per day. What is the length of the stem at the end of the 7th day?
(1) 230 cm
(2) 460 cm
(3) 50 cm
(4) 170 cm

2026 (RE-NEET)

2. Which plant growth regulator promotes internode elongation prior to flowering in cabbage?
(1) Indole butyric acid
(2) Ethephon
(3) Abscisic acid
(4) Gibberellin

2026 (RE-NEET)

3. Which of the following plant growth regulators is used as herbicide?
(1) Abscisic acid
(2) Gibberellin
(3) 2,4-D
(4) Kinetin

2026 (CANCELLED)

4. Which one of the following is NOT a characteristic of plant cells in the phase of elongation?
(1) New cell wall deposition
(2) Cell enlargement
(3) Increased vacuolation
(4) Large conspicuous nuclei

2026 (CANCELLED)

5. Match List I with List II:
List I (Growth Regulator):
A. 2,4-D
B. GA_3
C. Kinetin
D. ABA
List II (Function/Effect):
I. Brewing industry
II. Stimulation of stomatal closure
III. Herbicide
IV. Nutrient mobilisation
(1) A-III, B-I, C-IV, D-II
(2) A-IV, B-III, C-III, D-I
(3) A-I, B-IV, C-III, D-II
(4) A-I, B-III, C-IV, D-III

2026 (CANCELLED)

6. Heterophyllous development in response to environment is an example of which of the following phenomena?
(1) Redifferentiation
(2) Elasticity
(3) Dedifferentiation
(4) Plasticity

2024

7. Formation of interfascicular cambium from fully developed parenchyma cells is an example of
(1) differentiation
(2) redifferentiation
(3) dedifferentiation
(4) maturation.

RE-EXAM 2024

8. Match List-I with List- II.

List-I (Plant Hormones)		List-II (Functions)	
A.	Abscisic acid	I.	Promotes female flowers in cucumber
B.	Ethylene	II.	Helps seeds to withstand desiccation
C.	Gibberellin	III.	Helps in nutrient mobilisation
D.	Cytokinin	IV.	Promotes bolting in beet, cabbage, etc.

Choose the correct answer from the options given below.
(1) A-II, B-III, C-IV, D-I
(2) A-III, B-II, C-I, D-IV
(3) A-II, B-I, C-IV, D-III
(4) A-II, B-I, C-III, D-IV

RE-EXAM 2024

9. F. Skoog observed that callus proliferated from the internodal segments of tobacco stem when auxins was supplied with one of the following except

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(1) extract of vascular tissues
(2) coconut milk
(3) abscisic acid
(4) yeast extract.

RE-EXAM 2024

10. Given below are some statements about plant growth regulators.
A. All GAs are acidic in nature.
B. Auxins are antagonists to GAs.
C. Zeatin was isolated from coconut milk.
D. Ethylene induces flowering in mango.
E. Abscisic acid induces parthenocarpy.
Choose the correct set of statements from the options given below.
(1) A, C, D
(2) B, E
(3) A, B, C
(4) B, D, E

2024

11. Auxin is used by gardeners to prepare weed-free lawns. But no damage is caused to grass as auxin
(1) promotes apical dominance
(2) promotes abscission of mature leaves only
(3) does not affect mature monocotyledonous plants
(4) can help in cell division in grasses, to produce growth.

2024

12. Spraying sugarcane crop with which of the following plants growth regulators, increases the length of stem, thus, increasing the yield?
(1) Auxin
(2) Gibberellin
(3) Cytokinin
(4) Abscisic acid

Manipur NEET 2023

13. Which of the following statements is not correct?
(1) Phase of cell elongation of plant cells is characterised by increased vacuolation.
(2) Cells in the meristematic phase of growth exhibit abundant plasmodesmatal connections.
(3) Plant growth is generally determinate.
(4) Plant growth is measurable.

2023

14. In tissue culture experiments, leaf mesophyll cells are put in a culture medium to form callus. This phenomenon may be called as
(1) development
(2) senescence
(3) differentiation
(4) dedifferentiation.

2023

15. Read the following statements on plant growth and development.
A. Parthenocarpy can be induced by auxins.
B. Plant growth regulators can be involved in promotion as well as inhibition of growth.
C. Dedifferentiation is a pre-requisite for re-differentiation
D. Abscisic acid is a plant growth promoter.
E. Apical dominance promotes the growth of lateral buds.
Choose the option with all correct statements.
(1) A, D, E only
(2) B, D, E only
(3) A, B, C only
(4) A, C, E only

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2023

16. Which one of the following phytohormones promotes nutrient mobilization which helps in the delay of leaf senescence in plants?
(1) Gibberellin
(2) Cytokinin
(3) Ethylene
(4) Abscisic acid

Manipur NEET 2023

17. The phenomenon which is influenced by auxin and also played a major role in its discovery.
(1) Phototropism
(2) Root initiation
(3) Gravitropism
(4) Apical Dominance

Manipur NEET 2023

18. Match List-I with List-II.

List I (Plant Harmones)			List II (Functions)
A.	Auxin	(I)	Promotes female flower formation in cucumber
B.	Gibberellin	(II)	Overcoming apical dominance
C.	Cytokinin	(III)	Increase in the length of grape stalks
D.	Ethylene	(IV)	Promotes flowering in pineapple

Choose the correct answer from the options given below.

(1) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)
(2) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)
(3) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)
(4) (A)-(III), (B)-(II), (C)-(I), (D)-(IV)

2023

19. Which hormone promotes internode/petiole elongation in deep water rice?
(1) Ethylene
(2) 2, 4-D
(3) GA_3
(4) Kinetin

2022

20. Which one of the following plants does not show plasticity?
(1) Cotton
(2) Coriander
(3) Buttercup
(4) Maize

2022

21. Spraying of which of the following phytohormone on juvenile conifers helps in hastening the maturity period, that leads to early seed production?
(1) Zeatin
(2) Abscisic Acid
(3) Indole-3-butyric Acid
(4) Gibberellic Acid

2022

22. The gaseous plant growth regulator is used in plants to
(1) speed up the malting process
(2) promote root growth and root hair formation to increase the absorption surface
(3) help overcome apical dominance
(4) kill dicotyledonous weeds in the fields.

2022

23. Production of cucumber has increased manifold in recent years. Application of which of the following phytohormones has resulted in this increased yield as the hormone is known to produce female flowers in the plants
(1) ABA
(2) gibberellin
(3) ethylene
(4) cytokinin

2021

24. Plants follow different pathways in response to environment or phases of life to form different kinds of structures. This ability is called
(1) maturity
(2) elasticity
(3) flexibility
(4) plasticity.

2021

25. The plant hormone used to destroy weeds in a field is
(1) IBA
(2) IAA
(3) NAA
(4) 2, 4-D.

2020

26. The process of growth is maximum during
(1) log phase
(2) lag phase
(3) senescence
(4) dormancy.

2020

27. Name the plant growth regulator which upon spraying on sugarcane crop, increases the length of stem, thus increasing the yield of sugarcane crop.
(1) Cytokinin
(2) Gibberellin
(3) Ethylene
(4) Abscisic acid

2020

28. Which of the following is not an inhibitory substance governing seed dormancy?
(1) Gibberellic acid
(2) Abscisic acid
(3) Phenolic acid
(4) Para-ascorbic acid

2019

29. It takes very long time for pineapple plants to produce flowers. Which combination of hormones can be applied to artificially induce flowering in pineapple plants throughout the year to increase yield?
(1) Cytokinin and Abscisic acid
(2) Auxin and Ethylene
(3) Gibberellin and Cytokinin
(4) Gibberellin and Abscisic acid

2017

30. Fruit and leaf drop at early stages can be prevented by the application of
(1) ethylene
(2) auxins
(3) gibberellic acid
(4) cytokinins.

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NEET-II 2016

31. You are given a tissue with its potential for differentiation in an artificial culture. Which of the following pairs of hormones would you add to the medium to secure shoots as well as roots?
(1) IAA and gibberellin
(2) Auxin and cytokinin
(3) Auxin and abscisic acid
(4) Gibberellin and abscisic acid

NEET-I 2016

32. The Avena curvature is used for bioassay of
(1) IAA (2) ethylene
(3) ABA (4) GA_3.

2015 Cancelled

33. Typical growth curve in plants is
(1) stair-steps shaped
(2) parabolic
(3) sigmoid
(4) linear.

2015

34. Auxin can be bioassayed by
(1) potometer
(2) lettuce hypocotyl elongation
(3) Avena coleoptile curvature
(4) hydroponics.

2015 Cancelled

35. What causes a green plant exposed to the light, on only one side, to bend towards the source of light as it grows?
(1) Light stimulates plant cells on the lighted side to grow faster.
(2) Auxin accumulates on the shaded side, stimulating greater cell elongation there.
(3) Green plants need light to perform photosynthesis.
(4) Green plants seek light because they are phototropic.

2014

36. Dr. F. Went noted that if coleoptile tips were removed and placed on agar for one hour, the agar would produce a bending when placed on one side of freshly-cut coleoptile stumps. Of what significance is this experiment?
(1) It made possible the isolation and exact identification of auxin.
(2) It is the basis for quantitative determination of small amounts of growth-promoting substances.
(3) It supports the hypothesis that IAA is auxin.
(4) It demonstrated polar movement of auxins.

2014

37. Which one of the following growth regulators is known as 'stress hormone'?
(1) Abscisic acid
(2) Ethylene
(3) GA_3
(4) Indole acetic acid

2013

38. During seed germination, its stored food is mobilized by
(1) ABA
(2) gibberellin
(3) ethylene
(4) cytokinin.

Karnataka NEET 2013

39. The pineapple which under natural condition is difficult to blossom has been made to produce fruits throughout the year by application of
(1) NAA, 2, 4-D
(2) Phenyl acetic acid
(3) Cytokinin
(4) IAA, IBA.

NODIA

Mains 2012

40. Through their effects on plant growth regulators, what do the temperature and light control in the plants?
(1) Apical dominance
(2) Flowering
(3) Closure of stomata
(4) Fruit elongation

Mains 2012

41. Which one of the following generally acts as an antagonist to gibberellins?
(1) Zeatin (2) Ethylene
(3) ABA (4) IAA

2010

42. Phototropic curvature is the result of uneven distribution of
(1) gibberellin
(2) phytochrome
(3) cytokinins
(4) auxin.

Mains 2010

43. One of the commonly used plant growth hormone in tea plantations is
(1) ethylene
(2) abscisic acid
(3) zeatin
(4) indole-3-acetic acid.

stages of aerobic respiration. This process occurs in the mitochondria and uses energy derived from the oxidation of nutrients and the subsequent transfer of electrons through chain.

58. (3) carbon dioxide, water and energy
Aerobic respiration is the process by which cells break down glucose in the presence of oxygen to release chemical energy. The carbon atoms from the substrate are completely oxidized and released as carbon dioxide. The hydrogen atoms eventually react with oxygen to form water. Consequently, the primary end products of this metabolic pathway are carbon dioxide, water, and energy stored in ATP.

59. (4) Cyt a_3.
The electron transport chain ends with a protein complex known as cytochrome c oxidase, or Complex IV. This complex contains two heme groups, cytochrome a and cytochrome a_3, along with copper centers. Cytochrome a_3 serves as the terminal electron carrier in the respiratory chain. It directly transfers the low-energy electrons to molecular oxygen, which then combines with protons to form water.

60. (2) 38 ADP molecules into 38 ATP molecules
During the complete aerobic oxidation of one molecule of glucose, the energy released is used to phosphorylate adenosine diphosphate into adenosine triphosphate. Based on classic respiratory balance sheets, the total theoretical yield from glycolysis, the link reaction, and the Krebs cycle combined with oxidative phosphorylation can reach 38 ATP. Thus, the process effectively converts 38 molecules of ADP into 38 molecules.

61. (2) 2 are produced outside mitochondria and 34 inside mitochondria
In many eukaryotic organisms, the net yield from glucose oxidation is 36 ATP molecules. Glycolysis occurs in the cytosol and produces two ATP molecules directly through substrate-level phosphorylation. The remaining 34 ATP molecules are generated inside the mitochondria. This includes the ATP produced during the Krebs cycle and the much larger amount synthesized via oxidative phosphorylation in the electron transport chain.

62. (4) acetyl CoA.
Acetyl CoA is a central molecule in metabolism that serves as a common intersection for various biochemical pathways. It is the product of pyruvate oxidation from glycolysis and the primary product of the beta-oxidation of fatty acids. By entering the tricarboxylic acid cycle, it allows for the integrated oxidation of carbohydrates and fats, facilitating energy production from diverse nutritional sources.

63. (3) respirometer
A respirometer is a specialized laboratory instrument used to measure the rate of respiration in living organisms, such as germinating seeds or small animals. It functions by monitoring the exchange of gases, specifically the consumption of oxygen and the evolution of carbon dioxide. This data allows for the calculation of the respiratory quotient, providing insight into the substrate being oxidized.

64. (2) pyruvic acid
Glycolysis is the metabolic pathway that initiates the breakdown of glucose in the cytosol of the cell. It consists of a series of ten enzymatic steps that convert one six-carbon glucose molecule into two three-carbon molecules. The final compound produced at the end of this sequence is pyruvic acid. This product can subsequently enter the mitochondria for further oxidation.

65. (4) acetyl CoA.
After glycolysis occurs in the cytoplasm, the resulting pyruvate is transported into the mitochondrial matrix. Here, it undergoes oxidative decarboxylation, a reaction catalyzed by the pyruvate dehydrogenase complex. During this process, a carbon atom is released as CO_2 and the remaining two-carbon acetyl group is attached to coenzyme A. The resulting acetyl CoA is the molecule that enters the cycle.

66. (2) 8 ATP
The Embden-Meyerhof-Parnas pathway, commonly known as glycolysis, generates energy through two mechanisms. First, it produces two ATP molecules directly via substrate-level phosphorylation. Second, it generates two molecules of NADH. If these NADH molecules are oxidized through the electron transport chain under aerobic conditions, they can yield an additional six ATP molecules, bringing the total potential production to eight ATP.

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2001

58. Which hormone breaks dormancy of potato tuber?
(1) Gibberellin (2) IAA
(3) ABA (4) Zeatin

2000

59. If the apical bud has been removed then we observe
(1) more lateral branches
(2) more axillary buds
(3) plant growth stops
(4) flowering stops.

2000

60. Which hormone is responsible for fruit ripening?
(1) Ethylene (2) Auxin
(3) Ethyl chloride (4) Cytokinin

1999

61. ABA is involved in
(1) shoot elongation
(2) increased cell division
(3) dormancy of seeds
(4) root elongation.

1998

62. A plant hormone used for inducing morphogenesis in plant tissue culture is
(1) cytokinins
(2) ethylene
(3) abscisic acid
(4) gibberellins.

1998

63. Which combination of gases is suitable for fruit ripening?
(1) 80% CH_4 and 20% CO_2
(2) 80% CO_2 and 20% O_2
(3) 80% C_2H_4 and 20% CO_2
(4) 80% CO_2 and 20% CH_2

1998

64. Which one among the following chemicals is used for causing defoliation of forest trees?
(1) Malic hydrazide
(2) 2, 4-D
(3) Amo-1618
(4) Phosphon D

1997

65. Gibberellic acid induces flowering
(1) in short day plants under long day conditions
(2) in day-neutral plants under dark conditions
(3) in some gymnospermic plants only
(4) in long day plants under short day conditions.

1994

66. The movement of auxin is largely
(1) centripetal
(2) basipetal
(3) acropetal
(4) both (1) and (3).

1994

67. If the growing plant is decapitated, then
(1) its growth stops
(2) leaves become yellow and fall down
(3) axillary buds are inactivated
(4) axillary buds are activated.

1993

68. Removal of apical bud results in
(1) formation of new apical bud
(2) elongation of main stem
(3) death of plant
(4) formation of lateral branching.

1993

69. The regulator which retards ageing/senescence of plant parts is
(1) cytokinin
(2) auxin
(3) gibberellin
(4) abscisic acid.

1993

70. The hormone produced during adverse environmental conditions is
(1) benzyl aminopurine
(2) bichlorophenoxy acetic acid
(3) ethylene
(4) abscisic acid.

1993

71. Klinostat is employed in the study of
(1) osmosis
(2) growth movements
(3) photosynthesis
(4) respiration.

1993

72. Which is produced during water stress that brings stomatal closure?
(1) Ethylene (2) Abscisic acid
(3) Ferulic acid (4) Coumarin

1992

73. Bananas can be prevented from over-ripening by
(1) maintaining them at room temperature
(2) refrigeration
(3) dipping in ascorbic acid solution
(4) storing in a freezer.

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1992

74. Apical dominance is caused by
(1) abscisic acid in lateral bud
(2) cytokinin in leaf tip
(3) gibberellin in lateral buds
(4) auxin in shoot tip.

1992

75. Cytokinins
(1) promote abscission
(2) influence water movement
(3) help retain chlorophyll
(4) inhibit protoplasmic streaming.

1992

76. Which is employed for artificial ripening of banana fruits?
(1) Auxin
(2) Coumarin
(3) Ethylene
(4) Cytokinin

1991

77. Abscisic acid causes
(1) stomatal closure
(2) stem elongation
(3) leaf expansion
(4) root elongation.

1991

78. The hormone responsible for apical dominance is
(1) IAA (2) GA
(3) ABA (4) Florigen.

1991, 1988

79. Hormone primarily connected with cell division is
(1) IAA
(2) NAA
(3) cytokinin/zeatin
(4) gibberellic acid.

1990

80. Highest auxin concentration occurs
(1) in growing tips
(2) in leaves
(3) at base of plant organs
(4) in xylem and phloem.

1990

81. Phytohormones are
(1) chemical regulating flowering
(2) chemical regulating secondary growth
(3) hormones regulating growth from seed to adulthood
(4) regulators synthesised by plants and influencing physiological processes.

1990

82. Abscisic acid controls
(1) cell division
(2) leaf fall and dormancy
(3) shoot elongation
(4) cell elongation and wall formation.

1990

83. Phototropic and geotropic movements are linked to
(1) gibberellins (2) enzymes
(3) auxin (4) cytokinins.

1990

84. Which of the following movement is not related to auxin level?
(1) Bending of shoot towards light
(2) Movement of root towards soil
(3) Nyctinastic leaf movements
(4) Movement of sunflower head tracking the sun

1989

85. Leaf fall can be prevented with the help of
(1) abscisic acid
(2) auxins
(3) florigen
(4) cytokinins.

1989

86. Mowing grass lawn facilitates better maintenance because
(1) wounding stimulates regeneration
(2) removal of apical dominance and stimulation of intercalary meristem
(3) removal of apical dominance
(4) removal of apical dominance and promotion of lateral meristem.

NODIA

1988

87. Cut or excised leaves remain green for long if induced to root or dipped in
(1) gibberellins
(2) cytokinins
(3) auxins
(4) ethylene.

1988

88. Gibberellins promote
(1) seed germination
(2) seed dormancy
(3) leaf fall
(4) root elongation.

ANSWERS

1. (1) 230 cm
In arithmetic growth, length increases by a constant amount each day.

$$\text{Length} = \text{initial length} + (\text{growth rate} \times \text{days})$$
$$= 20 + (30 \times 7)$$
$$= 20 + 210 = 230 \text{ cm}.$$

2. (4) Gibberellin
Gibberellins promote internode elongation and cause bolting (rapid internode elongation just before flowering) in rosette plants like cabbage. This stem elongation lifts flowers above the leaves.

3. (3) 2,4-D
2,4-D (2,4-dichlorophenoxyacetic acid) is a synthetic auxin widely used as a selective herbicide to kill dicotyledonous weeds without affecting mature monocots. The others are growth regulators with different functions.

4. (4) Large conspicuous nuclei
During the elongation phase, cells show enlargement, increased vacuolation and deposition of new cell wall material. Large, conspicuous nuclei are typical of actively dividing meristematic cells in the phase of cell division, not of the elongation phase, so this is not its characteristic.

5. (1) A-III, B-I, C-IV, D-II
2,4-D is used as a herbicide to kill dicot weeds. GA_3 (gibberellin) is used in the brewing industry to speed up malting. Kinetin (cytokinin) helps in nutrient mobilisation. ABA (abscisic acid) stimulates stomatal closure during stress, giving A-III, B-I, C-IV, D-II.

6. (4) Plasticity
Plasticity is the ability of plants to produce different structures (such as different leaf shapes) in response to environment or different life stages. Heterophylly, where leaves of different shapes form on the same plant, like in buttercup or cotton, is a classic example of developmental plasticity.

7. (3) dedifferentiation
Dedifferentiation is the process where mature, specialized cells regain their ability to divide and become meristematic under specific conditions. In plants, fully developed parenchyma cells can undergo this transition to form the interfascicular cambium. This allows for secondary growth by producing new vascular tissues. It is a vital mechanism for plant regeneration and increasing the girth of the plant.

8. (3) A-II, B-I, C-IV, D-III
Plant hormones regulate various physiological processes. Abscisic acid helps seeds withstand desiccation by inducing dormancy. Ethylene promotes female flower production in crops like cucumber. Gibberellins are responsible for bolting in rosette plants such as beet and cabbage. Cytokinins facilitate nutrient mobilization, which delays leaf senescence. Each hormone plays a specific role in plant growth and environmental adaptation.

9. (3) abscisic acid
Callus proliferation in tobacco stem segments requires both auxin and a cytokinin source. F. Skoog found that substances like vascular tissue extract, coconut milk, and yeast extract provided the necessary nutrients and hormones for cell division. However, abscisic acid is a growth inhibitor and does not promote the formation or proliferation of callus in tissue culture systems under these conditions.

10. (1) A, C, D
Gibberellins are a group of acidic plant growth regulators. Zeatin, a natural cytokinin, was first isolated from corn kernels and is also found in coconut milk. Ethylene is a gaseous hormone that induces flowering in mango trees. Auxins and gibberellins are usually not antagonistic, and abscisic acid typically inhibits growth rather than inducing parthenocarpy in most plant species.

11. (3) does not affect mature monocotyledonous plants
Synthetic auxins like 2,4-D are widely used as selective herbicides. They effectively kill broad-leaved dicotyledonous weeds by disrupting their normal growth patterns. However, mature monocotyledonous plants, including common

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lawn grasses, are not significantly affected by these concentrations. This specificity allows gardeners to maintain weed-free lawns without harming the grass, ensuring healthy and uniform turf growth in various landscapes.

12. (2) Gibberellin
Sugarcane stores carbohydrates as sugar in its stems. Spraying the crop with gibberellins promotes internode elongation, which significantly increases the length of the stem. Since the yield is directly related to the stem length, this application enhances overall sugar production. It is a common agricultural practice used to maximize productivity in sugarcane farming and improve the overall economic output.

13. (3) Plant growth is generally determinate.
Plant growth is unique because it is generally indeterminate, meaning plants retain the capacity for unlimited growth throughout their lifespan. This is due to the presence of meristems at specific locations. In contrast, cell elongation involves increased vacuolation, and meristematic cells have abundant plasmodesmata. Growth is also measurable through various parameters like fresh weight, dry weight, and stem length.

14. (4) dedifferentiation.
Dedifferentiation occurs when specialized, mature cells, such as leaf mesophyll cells, lose their structural and functional specialization to become meristematic again. In tissue culture, this process allows these cells to divide rapidly and form an unorganized mass of cells known as a callus. It is a fundamental step in plant biotechnology for regenerating whole plants from various somatic tissues.

15. (3) A, B, C only
Auxins are known to induce parthenocarpy, which is the production of fruit without fertilization. Plant growth regulators can act as promoters or inhibitors depending on the context and concentration. Dedifferentiation must occur before cells can undergo redifferentiation into new specialized structures. Abscisic acid is primarily a growth inhibitor, while apical dominance actually suppresses the growth of lateral buds.

16. (2) Cytokinin
Cytokinins play a crucial role in delaying the aging process, or senescence, in plant leaves. They achieve this by promoting the mobilization of nutrients towards the treated areas, ensuring that essential resources are available for metabolic activities. This "Richmond-Lang effect" helps maintain chlorophyll levels and structural integrity, keeping the leaves green and functional for a much longer duration.

NODIA

17. (1) Phototropism
The discovery of auxin is closely linked to observations of phototropism in canary grass coleoptiles by Charles and Francis Darwin. They noticed that the coleoptile tip perceives light and produces a signal that causes bending toward the source. Later experiments confirmed that this signal is the hormone auxin, which redistributes to the shaded side, causing differential cell elongation there.

18. (2) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)
Auxins are used to promote flowering in crops like pineapple. Gibberellins are effective in increasing the length of grape stalks, which improves fruit spacing. Cytokinins are known for their ability to overcome apical dominance, encouraging lateral bud growth. Ethylene is a gaseous hormone that promotes the formation of female flowers in cucumbers, which is essential for increasing overall yield.

19. (1) Ethylene
In deep-water rice varieties, ethylene plays a vital role in survival during flooding. It triggers rapid internode or petiole elongation, allowing the upper parts of the plant, especially the leaves and terminal buds, to remain above the rising water surface. This response ensures that the plant can continue photosynthesis and gas exchange even when the lower portions are completely submerged.

20. (4) Maize
Plasticity is the ability of plants to follow different pathways in response to the environment or life stages, resulting in different structures. Cotton, coriander, and buttercup exhibit heterophylly, a form of plasticity where leaf shapes vary significantly. Maize, however, does not show this type of developmental or environmental plasticity in its leaf morphology, maintaining consistent structures throughout its life.

21. (4) Gibberellic Acid
Gibberellic acid is used in forestry to accelerate the developmental stages of certain plants. When applied to juvenile conifers, it hastens the transition from the vegetative phase to the reproductive phase. This results in early maturity and premature seed production, which is highly beneficial for breeding programs and commercial seed collection by reducing the time required for tree maturation.

22. (2) promote root growth and root hair formation to increase the absorption surface
Ethylene is a gaseous plant growth regulator with various physiological effects. One of its important functions is to stimulate root growth and the formation of root hairs. By increasing the number of root hairs, the plant expands its total root surface area. This enhancement significantly improves the efficiency of water and mineral absorption from the soil, supporting overall plant growth.

23. (3) ethylene
Ethylene is a gaseous hormone that significantly influences the sex expression of certain plants. In cucumber cultivation, the application of ethylene or ethylene-releasing compounds like ethephon promotes the development of female flowers. An increased number of female flowers leads to a higher fruit set and manifold increases in yield, making it a valuable tool for modern agricultural productivity.

24. (4) plasticity.
Plasticity refers to the inherent capacity of plants to alter their growth and developmental patterns in response to environmental changes or internal life stages. This often results in the production of different anatomical or morphological structures, such as varying leaf shapes in heterophylly. This adaptability allows plants to survive and thrive in diverse ecological conditions by optimizing their functional architecture.

25. (4) 2, 4-D.
2,4-Dichlorophenoxyacetic acid is a synthetic auxin widely employed as a selective herbicide in agriculture and landscaping. It specifically targets and kills broad-leaved dicotyledonous weeds without causing significant damage to monocotyledonous plants like cereal crops or lawn grasses. By mimicking natural growth hormones, it induces uncontrolled and lethal growth in sensitive weed species, ensuring efficient and effective weed management.

26. (1) log phase
The growth of a plant or its parts typically follows an S-shaped or sigmoid curve. After an initial slow lag phase, the growth rate increases rapidly and becomes exponential during the log phase. During this period, cells divide and enlarge at their maximum capacity due to abundant resources and optimal conditions, leading to the most significant increase in size and mass.

27. (2) Gibberellin
Gibberellins are vital plant hormones that regulate various developmental processes, including stem elongation. In sugarcane, spraying these regulators causes the internodes to stretch, resulting in a significantly taller plant. Since sugar is stored within the stem tissues, increasing the stem length directly leads to a higher biomass and improved sugar yield, providing a substantial economic advantage for commercial farmers.

28. (1) Gibberellic acid
Seed dormancy is often maintained by chemical inhibitors that prevent germination until favorable conditions occur. Substances like abscisic acid, phenolic acids, and para-ascorbic acid act as inhibitors to keep the seed dormant. In contrast, gibberellic acid is a growth promoter that actively breaks dormancy by stimulating the synthesis of enzymes required for the mobilization of stored food reserves.

29. (2) Auxin and Ethylene
Pineapple plants often exhibit irregular flowering patterns under natural conditions. To achieve uniform and year-round production, a combination of auxin and ethylene is used. Auxins like NAA and ethylene-releasing agents like ethephon are applied to induce synchronous flowering across the entire plantation. This practice ensures a consistent harvest and increases the overall agricultural yield for commercial pineapple farming operations.

30. (2) auxins
The premature abscission of young fruits and leaves can lead to significant crop losses. Auxins are effective in preventing this early drop by inhibiting the formation of the abscission layer at the base of petioles and fruit stalks. While

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49. (3) treating the plants with low concentrations of gibberellic acid and auxins
Parthenocarpy is the development of fruit without fertilization, resulting in seedless produce. In tomatoes, this process can be artificially induced by applying low concentrations of growth regulators like gibberellic acid and auxins to the flowers. These hormones mimic the natural signals that trigger ovary development following pollination. This technique is commercially valuable for producing high-quality seedless fruits for consumers.

50. (3) It frees axillary buds from apical dominance.
Apical dominance is the phenomenon where the terminal bud inhibits the growth of lateral or axillary buds. This is mediated by auxins produced at the shoot tip. Pruning involves removing the apical buds, which stops the downward flow of these inhibitory signals. As a result, axillary buds are released from suppression and begin to grow, leading to a much bushier appearance.

51. (3) gibberellins.
Gibberellins are a class of plant hormones famous for their role in promoting internodal elongation. They stimulate both cell division and cell expansion in the regions between nodes. This effect is particularly striking in dwarf plants or rosette plants, where the application of gibberellins can lead to a sudden and dramatic increase in stem height, a process often called bolting.

52. (4) cytokinin.
Coconut milk was historically identified as a potent source of growth-promoting substances in plant tissue culture. Researchers discovered that it contains high levels of cytokinins, particularly zeatin and related compounds. These hormones are essential for stimulating cell division and promoting shoot differentiation. The inclusion of coconut milk in culture media revolutionized the ability to grow and regenerate plant tissues in vitro.

53. (1) auxin
Zinc is an essential micronutrient for plants because it serves as a cofactor for several enzymes. Most importantly, it is required for the biosynthesis of tryptophan, which is the direct amino acid precursor of Indole-3-acetic acid, the primary natural auxin. Consequently, plants deficient in zinc exhibit stunted growth and small leaves due to significantly reduced levels of auxin production.

54. (2) high cytokinin : auxin ratio
In plant morphogenesis, the relative concentration of different hormones determines the type of organ that develops from undifferentiated tissue. A high ratio of cytokinin to auxin in the growth medium promotes the initiation and development of shoots. Conversely, a low cytokinin to auxin ratio favors the formation of roots. This hormonal balance is fundamental in plant tissue culture and regeneration.

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55. (2) gibberellic acid
Genetic dwarfness in many plants is often caused by a deficiency in the production or sensitivity to gibberellins. These hormones are responsible for promoting internode elongation. By applying exogenous gibberellic acid to dwarf varieties, such as certain peas or corn, the plants can be induced to grow to normal heights. This demonstrates the critical role of gibberellins in regulating stem stature.

56. (2) NAA
Naphthalene acetic acid is a synthetic auxin used extensively in agriculture to manage fruit development. One of its primary applications is to prevent the premature abscission, or "drop," of fruits before they are ready for harvest. By inhibiting the formation of the abscission layer at the base of the fruit stalk, NAA ensures that the fruit remains attached until maturity.

57. (1) ABA
Abscisic acid is often associated with the later stages of plant development and stress responses. It plays a significant role in promoting senescence, which is the programmed aging of plant tissues. This hormone triggers the breakdown of proteins and chlorophyll, leading to the yellowing and eventual death of leaves and other organs, facilitating the recycling of nutrients to other parts.

58. (1) Gibberellin
Potato tubers often undergo a period of dormancy after harvest during which they will not sprout. Ethylene is effective in breaking this dormancy and initiating the growth of buds. It triggers the transition of buds into an active state, facilitating the development of sprouts.

market demands consistently and improving economic returns.

40. (2) Flowering
Light and temperature are critical environmental cues that regulate the transition from vegetative to reproductive growth in many plants. Photoperiodism refers to the response to the duration of light, while vernalization is the requirement for a cold period to induce flowering. These factors influence the synthesis and activity of plant growth regulators, ensuring that flowering occurs during favorable seasonal conditions.

41. (3) ABA
Abscisic acid and gibberellins often act antagonistically in regulating various plant processes. While gibberellins promote seed germination and break dormancy, abscisic acid induces and maintains dormancy. Similarly, gibberellins stimulate growth and cell elongation, whereas abscisic acid typically acts as a growth inhibitor. This balance between the two hormones allows the plant to respond appropriately to environmental conditions and its developmental needs.

42. (4) auxin.
Phototropism is the growth response of plants toward light. This curvature occurs because auxin, a growth-promoting hormone, is redistributed unequally across the stem or coleoptile when exposed to unilateral light. Auxin moves to the shaded side, where it stimulates greater cell elongation than on the lighted side. The resulting difference in growth rates causes the plant to bend toward the light.

43. (4) indole-3-acetic acid.
In tea plantations, maintaining a bushy habit with many lateral branches is essential for high leaf yields. This is achieved by removing the shoot tips, which are the primary sites of Indole-3-acetic acid synthesis. Removing the apical bud eliminates apical dominance, allowing axillary buds to grow. This practice, combined with auxin management, ensures a dense canopy and frequent leaf harvests.

44. (2) auxin
Auxins are instrumental in initiating and promoting root development in plants. They are frequently used in horticulture to stimulate root formation on stem cuttings, a process vital for vegetative propagation. While high concentrations can inhibit primary root elongation, appropriate levels of auxin trigger the formation of lateral and adventitious roots, enhancing the plant's ability to anchor itself and absorb essential nutrients.

45. (4) NAA.
While some auxins like Indole-3-acetic acid occur naturally in plants, several synthetic compounds have been developed for agricultural and horticultural use. Naphthalene acetic acid is a well-known synthetic auxin used to promote rooting, induce flowering, and prevent premature fruit drop. These synthetic regulators are often more stable and effective in practical applications than their naturally occurring counterparts found in plant tissues.

46. (3) Abscisic acid
Abscisic acid is a vital plant growth inhibitor that belongs to the chemical class of carotenoid derivatives. Biologically, it is synthesized from carotenoid precursors within the chloroplasts and other plastids of plant cells. This relationship with carotenoids is significant for understanding its metabolic pathway. Abscisic acid regulates several key processes, including seed maturation, dormancy, and response to various environmental stresses.

47. (4) leaf abscission.
Senescence is a programmed developmental process that leads to the aging and eventual death of plant parts or the whole plant. It involves the organized breakdown of cellular components and the mobilization of nutrients. Leaf abscission is a clear indicator of senescence, where leaves turn yellow due to chlorophyll loss and eventually detach from the plant through an organized abscission layer.

48. (1) Gibberellic acid - Leaf fall
Gibberellic acid is primarily a growth-promoting hormone involved in stem elongation, seed germination, and flowering. It does not typically cause leaf fall. In contrast, cytokinins promote cell division, and auxins like IAA are involved in cell wall elongation. Abscisic acid is well-known for inducing stomatal closure under stress. Leaf fall or abscission is generally regulated by abscisic acid and ethylene.

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of lateral branches, which is a common technique used in gardening and agriculture to increase plant bushiness.

69. (1) cytokinin
Cytokinins are effective in delaying the process of senescence, or aging, in plant organs. They help maintain metabolic activity and prevent the breakdown of proteins and nucleic acids. By promoting the mobilization of nutrients to treated areas, they keep tissues like leaves green and functional for a longer period. This delay in senescence is often referred to as the Richmond-Lang effect.

70. (4) abscisic acid.
Abscisic acid is often called the stress hormone because its concentration increases significantly during adverse conditions like drought, cold, or high salinity. It coordinates the plant's physiological responses to survive these stresses. For example, it triggers the rapid closure of stomata to conserve water during water deficit. This adaptability is crucial for plant survival in fluctuating and harsh environmental conditions.

71. (2) growth movements
A klinostat is a specialized laboratory instrument used in plant physiology to study growth movements, particularly tropisms. It consists of a rotating disc or drum that slowly turns a plant, thereby neutralizing the unidirectional effect of gravity or light. By eliminating these external cues, researchers can observe the inherent growth patterns of the plant and study the mechanisms of geotropism.

72. (2) Abscisic acid
During periods of water deficit, plants synthesize high levels of abscisic acid, primarily in the roots and leaves. This hormone acts as a signal to the guard cells of the stomata, causing them to lose turgor and close. Stomatal closure reduces water loss through transpiration, which is a vital survival mechanism for plants facing drought or other forms of water stress.

73. (3) dipping in ascorbic acid solution
Over-ripening in fruits like bananas involves oxidative processes and the action of ethylene. Antioxidants such as ascorbic acid can help slow down these chemical changes. Dipping fruit in an ascorbic acid solution can inhibit some of the enzymes responsible for browning and tissue softening. This treatment helps extend the shelf life and maintain the quality of the fruit during storage.

74. (4) auxin in shoot tip.
Apical dominance is a physiological condition where the main central stem of the plant grows more strongly than other side stems. It is caused by the production of auxin in the shoot tip, or apical meristem. As this auxin moves downward, it inhibits the growth of axillary buds located in the leaf axils, preventing them from developing into lateral branches.

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75. (3) help retain chlorophyll
Cytokinins are plant hormones that play a significant role in delaying the aging process of leaves. They help maintain the structural integrity of chloroplasts and prevent the degradation of chlorophyll and proteins. This effect ensures that leaves stay green and continue to perform photosynthesis for a longer duration. This ability to retain chlorophyll is a key characteristic of cytokinin action.

76. (3) Ethylene
Ethylene is a natural gaseous hormone that coordinates the ripening process in many fruits. Because it is highly effective at low concentrations, it is widely used commercially for the artificial ripening of bananas. By exposing green, harvested bananas to ethylene gas or ethylene-releasing agents, the conversion of starch to sugar and the softening of the fruit are synchronized for market.

77. (1) stomatal closure
Abscisic acid is a major plant hormone involved in responding to environmental stress. Its most well-known action is inducing the rapid closure of stomata when the plant experiences water deficiency. This prevents excessive water loss through transpiration, helping the plant maintain its water balance during drought. This physiological response is essential for the survival of plants in dry or unpredictable environments.

78. (1) IAA
Apical dominance is the phenomenon where the terminal bud of a plant suppresses the growth of the lateral buds. This process is mediated by Indole-3-acetic acid, the most common natural auxin. IAA is synthesized at the shoot apex and transported basipetally, where it maintains

This treatment is useful for ensuring uniform sprouting in various agricultural practices.

59. (1) more lateral branches
The apical bud of a plant produces auxins that move downward and inhibit the growth of lateral buds, a phenomenon known as apical dominance. When the apical bud is removed, this inhibitory effect is eliminated. Consequently, the axillary buds are released from suppression and begin to develop into lateral branches. This results in a fuller, bushier plant habit with increased branching.

60. (1) Ethylene
Ethylene is a gaseous plant hormone that acts as a key regulator of fruit ripening. It triggers various physiological and biochemical changes, such as the breakdown of chlorophyll, softening of the fruit cell walls, and the conversion of starches into sugars. Many fruits produce a burst of ethylene as they mature, which coordinates the ripening process across the entire fruit.

61. (3) dormancy of seeds.
Abscisic acid is a critical growth inhibitor that plays a central role in seed development. It induces and maintains seed dormancy, preventing premature germination during unfavorable conditions or while still on the parent plant. By inhibiting growth and metabolic activity, it ensures that the seed remains viable until the environment is suitable for successful establishment, thus acting as an anti-gibberellin.

62. (1) cytokinins
Morphogenesis in plant tissue culture involves the development of organized structures like shoots and roots from unorganized callus tissue. Cytokinins are primarily used to induce shoot formation. When the ratio of cytokinin to auxin is high, it promotes the differentiation of buds and stems. This hormone is essential for regenerating whole plants from small tissue segments or single cells.

63. (3) 80% C_2H_4 and 20% CO_2
Fruit ripening is a physiological process heavily influenced by the presence of ethylene gas. In commercial settings, ethylene or ethylene-releasing compounds are used to induce rapid and uniform ripening in fruits like bananas, tomatoes, and citrus. This process is carefully controlled, as high concentrations of carbon dioxide can actually inhibit the ripening effect of ethylene.

64. (2) 2, 4-D.
2,4-Dichlorophenoxyacetic acid is a synthetic auxin that acts as a selective herbicide. At high concentrations, it causes abnormal growth and disrupts the physiological functions of broad-leaved plants, leading to the shedding of leaves, or defoliation. This property was historically exploited for clearing vegetation. In agriculture, it remains a common tool for controlling dicotyledonous weeds in cereal crops and lawns.

65. (4) in long day plants under short day conditions.
Many long-day plants require a specific duration of light to initiate flowering. In some cases, gibberellic acid can substitute for this light requirement. When applied to these plants under short-day conditions, which would normally prevent flowering, gibberellic acid triggers the transition to the reproductive phase. This demonstrates the hormone's ability to mimic the physiological signals normally provided by photoperiodic cues.

66. (2) basipetal
Auxin transport in plants is unique because it is predominantly polar, meaning it moves in a specific direction. In shoots, auxin is synthesized at the tips and travels downward toward the base. This downward movement is referred to as basipetal transport. This directional flow is crucial for maintaining apical dominance and regulating various developmental processes along the main axis of the plant.

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67. (4) axillary buds are activated.
Decapitation is the removal of the shoot apex, which is the primary source of auxin. In many plants, the presence of the apical bud inhibits the growth of lateral buds through apical dominance. When the tip is removed, the inhibitory auxin signal is lost. This allows the axillary buds to become active and grow into branches, resulting in a bushier plant growth.

68. (4) formation of lateral branching.
The apical bud regulates the growth pattern of a plant by suppressing the development of lateral buds via auxin production. This phenomenon is known as apical dominance. Removing the apical bud eliminates this suppression, allowing the axillary buds to grow. This leads to the formation

auxins promote the shedding of older, mature parts, their application to young tissues helps maintain attachment, ensuring better fruit development and yield.

31. (2) Auxin and cytokinin
In plant tissue culture, morphogenesis is controlled by the balance of specific hormones. A relatively high concentration of auxin compared to cytokinin promotes the initiation and development of roots. Conversely, a higher ratio of cytokinin to auxin induces the formation of shoots. By adjusting the concentrations of both hormones, researchers can successfully regenerate complete plantlets with both functional roots and shoots.

32. (1) IAA
A bioassay is a technique used to measure the concentration or potency of a substance by its effect on living tissue. The Avena curvature test, developed by Went, is a classic bioassay for Indole-3-acetic acid. It measures the degree of bending in oat coleoptiles caused by the uneven distribution of auxin, providing a quantitative method for assessing auxin activity in plants.

33. (3) sigmoid
Most living organisms and their organs exhibit a characteristic sigmoid or S-shaped growth curve. This pattern begins with a slow lag phase, followed by a rapid exponential or log phase where growth is maximal. Finally, growth slows down during the stationary phase as maturity is reached. This curve reflects the changing rate of biological processes over the entire lifespan of the organism.

34. (3) Avena coleoptile curvature
Bioassays are experimental procedures used to determine the biological activity of growth regulators. The Avena coleoptile curvature test is the most widely recognized bioassay for auxins. It relies on the hormone's ability to promote cell elongation on the shaded side of a decapitated oat coleoptile, resulting in a measurable bend. This method allows for the precise quantification of auxin hormone concentrations.

35. (2) Auxin accumulates on the shaded side, stimulating greater cell elongation there.
Phototropism is the directional growth of plants toward a light source. When a plant receives unilateral light, auxin migrates from the illuminated side to the shaded side of the stem. The higher concentration of auxin on the shaded side stimulates greater cell elongation compared to the lighted side. This differential growth causes the stem to curve progressively toward the light source.

36. (2) It is the basis for quantitative determination of small amounts of growth-promoting substances.
Went's experiments with agar blocks containing coleoptile tips were revolutionary in plant physiology. By demonstrating that the degree of coleoptile bending was proportional to the amount of growth substance in the agar, he established a method for bioassay. This provided the first quantitative means to determine the concentration of auxins, paving the way for further research into plant hormone identification and action.

37. (1) Abscisic acid
Abscisic acid is widely referred to as the stress hormone because it plays a critical role in plant responses to adverse environmental conditions. It mediates various defense mechanisms, such as inducing stomatal closure during water deficit to prevent excessive transpiration. Additionally, it increases the tolerance of plants to different types of stresses, including drought, salinity, and extreme temperatures, ensuring survival.

38. (2) gibberellin
Gibberellins are essential for initiating the germination process in seeds. Upon imbibition of water, the embryo releases gibberellins, which stimulate the synthesis of hydrolytic enzymes like alpha-amylase in the aleurone layer. These enzymes break down stored starch and other nutrients into simple sugars. This mobilization provides the necessary energy and building blocks for the growing seedling until it becomes photosynthetic.

39. (1) NAA, 2, 4-D
In commercial pineapple farming, achieving uniform flowering and fruiting is essential for efficient harvesting. Natural flowering is often unpredictable. The application of synthetic auxins, such as Naphthalene acetic acid and 2,4-Dichlorophenoxyacetic acid, can artificially induce synchronous flowering across the plantation. This allows farmers to produce fruits throughout the year and optimize yield, meeting

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the inhibition of axillary buds. Removing the apex removes the source of IAA, allowing lateral branching.

79. (3) cytokinin/zeatin
Cytokinins were first discovered as substances that promote cytokinesis, which is the actual division of the cell's cytoplasm. These hormones, such as naturally occurring zeatin, are essential for stimulating cell division in various plant tissues, including roots, shoots, and developing fruits. They work in conjunction with auxins to regulate the cell cycle and ensure proper growth and development throughout the plant.

80. (1) in growing tips
Auxins are primarily synthesized in the regions of active cell division and growth, such as the shoot apical meristems and young leaves. Consequently, the highest concentrations of this hormone are found in the growing tips of the plant. From these sites, auxin is transported downward to other parts of the plant, where it regulates processes like stem elongation and apical dominance.

81. (4) regulators synthesised by plants and influencing physiological processes.
Phytohormones, or plant growth regulators, are small chemical molecules produced naturally within various parts of the plant. They are typically synthesized in one location and may be transported to other sites to exert their effects. These substances play a crucial role in controlling and coordinating a wide range of physiological processes, including growth, development, flowering, and responses to the environmental stimuli.

82. (2) leaf fall and dormancy
Abscisic acid acts as a general plant growth inhibitor. It is particularly important in regulating developmental transitions such as seed and bud dormancy, ensuring that growth only occurs under favorable conditions. Additionally, it promotes the senescence of leaves and the formation of an abscission layer, which leads to leaf fall. These functions help the plant manage its resources and survive stress.

83. (3) auxin
Tropisms are directional growth responses to external stimuli like light and gravity. These movements are mediated by the unequal distribution of auxin within the plant tissues. In phototropism, auxin accumulates on the shaded side of the stem, causing it to bend toward light. In geotropism, auxin redistribution helps roots grow downward and shoots grow upward, ensuring proper orientation of the entire plant.

84. (3) Nyctinastic leaf movements
Tropisms such as phototropism and geotropism are regulated by the differential distribution of auxin, which causes unequal cell elongation. Solar tracking in sunflowers is also influenced by these hormonal gradients. However, nyctinastic movements, which are the daily rhythmic sleep movements of leaves, are typically controlled by changes in turgor pressure within specialized cells called pulvini, rather than by auxin-mediated growth patterns.

NODIA

85. (2) auxins
The premature shedding of leaves, known as abscission, can be managed using plant growth regulators. Auxins are known to inhibit the formation of the abscission layer at the base of the petiole. By maintaining high levels of auxin in young leaves, the plant prevents them from falling. However, as leaves age and auxin levels decrease, the abscission process is eventually naturally triggered.

86. (2) removal of apical dominance and stimulation of intercalary meristem
Mowing removes the shoot tips of grass, which eliminates apical dominance by reducing the supply of inhibitory auxins to lateral buds. This encourages the growth of more lateral branches, making the lawn denser. Furthermore, grasses possess intercalary meristems at the base of leaves and internodes. Frequent cutting stimulates these meristems, allowing the grass to regenerate quickly and maintain a healthy turf.

87. (2) cytokinins
When leaves are removed from a plant, they normally undergo rapid senescence, turning yellow as chlorophyll breaks down. If these excised leaves are treated with cytokinins or induced to form roots, which produce cytokinins, the aging process is significantly delayed. This is because cytokinins promote nutrient mobilization and maintain the metabolic health of the tissues, keeping them green for much longer.

2009

41. What is vital capacity of our lungs?
(1) Inspiratory reserve volume plus expiratory reserve volume
(2) Total lung capacity minus residual volume
(3) Inspiratory reserve volume plus tidal volume
(4) Total lung capacity minus expiratory reserve volume

2009

42. The haemoglobin of a human fetus
(1) has only 2 protein subunits instead of 4
(2) has a higher affinity for oxygen than that of an adult
(3) has a lower affinity for oxygen than that of the adult
(4) its affinity for oxygen is the same as that of an adult.

2006

43. Which one of the following statements is incorrect?
(1) The principle of countercurrent flow facilitates efficient respiration in gills of fishes.
(2) The residual air in lungs slightly decreases the efficiency of respiration in mammals.
(3) The presence of non-respiratory air sacs, increases the efficiency of respiration in birds.
(4) In insects, circulating body fluids serve to distribute oxygen to tissues.

2006

44. The majority of carbon dioxide produced by our body cells is transported to the lungs as
(1) attached to haemoglobin
(2) dissolved in the blood
(3) bicarbonates
(4) carbonates.

2004

45. Blood analysis of a patient reveals an unusually high quantity of carboxyhaemoglobin content. Which of the following conclusions is most likely to be correct?
The patient has been inhaling polluted air containing unusually high content of
(1) carbon disulphide
(2) chloroform
(3) carbon dioxide
(4) carbon monoxide.

2004

46. When CO_2 concentration in blood increases breathing becomes
(1) shallower and slow
(2) there is no effect on breathing
(3) slow and deep
(4) faster and deeper.

1999

47. Haemoglobin is a type of
(1) carbohydrate
(2) respiratory pigment
(3) vitamin
(4) skin pigment.

1999

48. The respiratory centres, which control inspiration and expiration, are located in
(1) diencephalon
(2) medulla oblongata
(3) cerebellum
(4) spinal cord.

1998

49. The exchange of gases in the alveoli of the lungs takes place by
(1) passive transport
(2) active transport
(3) osmosis
(4) simple diffusion.

1997

50. In lungs, the air is separated from the venous blood through
(1) transitional epithelium + tunica externa of blood vessel
(2) squamous epithelium + endothelium of blood vessel
(3) squamous epithelium + tunica media of blood vessel
(4) none of the above.

1996

51. Lungs are enclosed in
(1) periosteum
(2) perichondrium
(3) pericardium
(4) pleural membrane.

1996

52. When 1500 mL air is in the lungs, it is called
(1) residual volume
(2) inspiratory reserve volume
(3) vital capacity
(4) tidal volume.

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CHAPTER 14

Breathing and Exchange of Gases

2026 (RE-NEET)

1. In water, frogs respire using:
(1) lungs (2) trachea
(3) skin (4) buccal cavity

2026 (CANCELLED)

2. In humans, respiration occurs in the following steps. Arrange these steps in the correct order:
A. Diffusion of O_2 and CO_2 between blood and tissues.
B. Diffusion of O_2 and CO_2 across alveolar membrane.
C. Pulmonary ventilation by which atmospheric air is drawn in and CO_2-rich alveolar air is released out.
D. Cellular respiration.
E. Transport of gases by the blood.
Choose the correct answer from the options given below:
(1) A, B, C, D, E
(2) E, A, C, D, B
(3) C, B, E, A, D
(4) C, A, B, E, D

2026 (CANCELLED)

3. Match List I with List II:
List I (Respiratory Volume)
A. ERV (Expiratory Reserve Volume)
B. RV (Residual Volume)
C. IRV (Inspiratory Reserve Volume)
D. TV (Tidal Volume)
List II (Capacity in mL):
I. 2500-3000 mL
II. 500 mL
III. 1000-1100 mL
IV. 1100-1200 mL
(1) A-III, B-IV, C-I, D-II
(2) A-III, B-I, C-IV, D-II
(3) A-I, B-III, C-II, D-IV
(4) A-I, B-II, C-III, D-IV

2026 (CANCELLED)

4. Match List I with List II:
List I:
A. Molluscs
B. Reptiles
C. Adult amphibians
D. Amoeba
List II:
I. Pulmonary respiration only
II. Branchial respiration
III. Cellular respiration
IV. Pulmonary and Cutaneous respiration
Choose the correct answer from the options given below :
(1) A-II, B-I, C-IV, D-III
(2) A-I, B-II, C-IV, D-III
(3) A-II, B-I, C-III, D-IV
(4) A-III, B-II, C-I, D-IV

2025

5. Which one of the following statements refers to Reductionist Biology?
(1) Chemical approach to study and understand living organisms.
(2) Behavioural approach to study and understand living organisms.
(3) Physico-chemical approach to study and understand living organisms.
(4) Physiological approach to study and understand living organisms.

RE-EXAM 2024

6. Match List-I with List-II.

List-I (Lung Volumes/Capacities)		List-II (Definitions)	
A.	Residual volume	(I)	Maximum volume of air that can be breathed in after forced expiration
B.	Vital capacity	(II)	Volume of air inspired or expired during normal respiration
C.	Expiratory capacity	(III)	Volume of air remaining in lungs after forcible expiration

NODIA

D.	Tidal volume	(IV)	Total volume of air expired after normal inspiration

Choose the correct answer from the options given below.
(1) A-IV, B-III, C-II, D-I
(2) A-II, B-IV, C-I, D-III
(3) A-III, B-I, C-IV, D-II
(4) A-I, B-II, C-III, D-IV

2024

7. Match List I with List II.

List I (Lung Capacities)			List II (Components)
A.	Expiratory capacity	I.	Expiratory reserve volume+Tidal volume+ Inspiratory reserve volume
B.	Functional residual capacity	II.	Tidal volume + Expiratory reserve volume
C.	Vital capacity	III.	Tidal volume+ Inspiratory reserve volume
D.	Inspiratory capacity	IV.	Expiratory reserve volume + Residual volume

Choose the correct answer from the options given below.
(1) A-II, B-IV, C-I, D-III
(2) A-III, B-II, C-IV, D-I
(3) A-II, B-I, C-IV, D-III
(4) A-I, B-III, C-II, D-IV

RE-EXAM 2024

8. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : During the transportation of gases, about 20-25 percent of CO_2 is carried by haemoglobin as carbamino-haemoglobin.
Reason (R) : This binding is related to high pCO_2 and low pO_2 in tissues.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) A is true but R is false.
(2) A is false but R is true.
(3) Both A and R are true and R is the correct explanation of A.
(4) Both A and R are true but R is not the correct explanation of A.

2024

9. Which of the following factors are favourable for the formation of oxyhaemoglobin in alveoli?
(1) High pO_2 and High pCO_2
(2) High pO_2 and Lesser H^+ concentration
(3) Low pCO_2 and High H^+ concentration
(4) Low pCO_2 and High temperature

Manipur NEET 2023

10. Select the sequence of steps in respiration.
A. Diffusion of gases (O_2 and CO_2) across alveolar membrane.
B. Diffusion of O_2 and CO_2 between blood and tissues.
C. Transport of gases by the blood.
D. Pulmonary ventilation by which atmospheric air is drawn in and CO_2 rich alveolar air is released out.
E. Utilisation of O_2 by the cells for catabolic reactions are resultant release of CO_2.
Choose the correct answer from the options given below.
(1) (D), (A), (C), (B), (E)
(2) (C), (B), (A), (E), (D)
(3) (B), (C), (E), (D), (A)
(4) (A), (C), (B), (E), (D)

2023

11. Vital capacity of lung is
(1) IRV + ERV + TV - RV
(2) IRV + ERV + TV
(3) IRV + ERV
(4) IRV + ERV + TV + RV

2022

12. Which of the following is not the function of conducting part of respiratory system ?
(1) It clears inhaled air from foreign particles
(2) Inhaled air is humidified
(3) Temperature of inhaled air is brought to body temperature
(4) Provides surface for diffusion of O_2 and CO_2

2022

13. Under normal physiological conditions in human being every 100 mL of oxygenated blood can deliver ___ ml of O_2 to the tissues.
(1) 2 mL
(2) 5 mL
(3) 4 mL
(4) 10 mL

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2021

14. The partial pressures (in mm Hg) of oxygen (O_2) and carbon dioxide (CO_2) at alveoli (the site of diffusion) are
(1) $pO_2 = 159$ and $pCO_2 = 0.3$
(2) $pO_2 = 104$ and $pCO_2 = 40$
(3) $pO_2 = 40$ and $pCO_2 = 45$
(4) $pO_2 = 95$ and $pCO_2 = 40$

2021

15. Select the favourable conditions required for the formation of oxyhaemoglobin at the alveoli.
(1) Low pO_2, low pCO_2, more H^+, higher temperature
(2) High pO_2, low pCO_2, less H^+, lower temperature
(3) Low pO_2, high pCO_2, more H^+, higher temperature
(4) High pO_2, high pCO_2, less H^+, higher temperature

2020

16. Select the correct events that occur during inspiration.
(1) Contraction of diaphragm
(2) Contraction of external inter-costal muscles
(3) Pulmonary volume decreases
(4) Intra pulmonary pressure increases
(1) (1) and (2)
(2) (3) and (4)
(3) (1), (2) and (4)
(4) only (4)

2020

17. Identify the wrong statement with reference to transport of oxygen.
(1) Binding of oxygen with haemoglobin is mainly related to partial pressure of O_2.
(2) Partial pressure of CO_2 can interfere with O_2 binding with haemoglobin.
(3) Higher H^+ conc. in alveoli favours the formation of oxyhaemoglobin.
(4) Low pCO_2 in alveoli favours the formation of oxyhaemoglobin.

2019

18. Tidal volume and expiratory reserve volume of an athlete is 500 mL and 1000 mL respectively. What will be his expiratory capacity if the residual volume is 1200 mL?
(1) 2700 mL
(2) 1500 mL
(3) 1700 mL
(4) 2200 mL

Odisha NEET 2019

19. Select the correct statement.
(1) Expiration occurs due to external intercostal muscles.
(2) Intrapulmonary pressure is lower than the atmospheric pressure during inspiration.
(3) Inspiration occurs when atmospheric pressure is less than intrapulmonary pressure.
(4) Expiration is initiated due to contraction of diaphragm.

2019

20. Due to increasing air-borne allergens and pollutants, many people in urban areas are suffering from respiratory disorder that cause wheezing due to
(1) reduction in the secretion of surfactant by pneumocytes
(2) benign growth on mucous lining of nasal cavity
(3) inflammation of bronchi and bronchioles
(4) proliferation of fibrous tissues and damage of the alveolar walls.

2018

21. Match the items given in column I with those in column II and select the correct option given below.

	Column I		Column II
(A)	Tidal volume	(i)	2500 - 3000 mL
(B)	Inspiratory reserve volume	(ii)	1100 - 1200 mL
(C)	Expiratory reserve volume	(iii)	500 - 550 mL
(D)	Residual volume	(iv)	1000 - 1100 mL

(1) (A)-(iii); (B)-(ii); (C)-(i); (D)-(iv)
(2) (A)-(iii); (B)-(i); (C)-(iv); (C)-(ii)
(3) (A)-(i); (B)-(iv); (C)-(ii); (C)-(iii)
(4) (A)-(iv); (B)-(iii); (C)-(ii); (C)-(i)

2018

22. Which of the following options correctly represents the lung conditions in asthma and emphysema, respectively?
(1) Inflammation of bronchioles; Decreased respiratory surface
(2) Increased number of bronchioles; Increased respiratory surface
(3) Increased respiratory surface; Inflammation of bronchioles
(4) Decreased respiratory surface; Inflammation of bronchioles

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ANSWERS

1. (3) skin
When in water, frogs respire entirely through their moist, vascular skin by cutaneous respiration, where dissolved oxygen diffuses directly into the blood. On land they use lungs along with skin and buccal cavity, but underwater the skin is the sole respiratory surface.

2. (3) C, B, E, A, D
Respiration begins with pulmonary ventilation (C), then diffusion of gases across the alveolar membrane (B), followed by transport of gases by the blood (E). Next, gases diffuse between blood and tissues (A), and finally cellular respiration (D) utilises oxygen in cells, giving the order C, B, E, A, D.

3. (1) A-III, B-IV, C-I, D-II
Expiratory Reserve Volume is about 1000-1100 mL, Residual Volume is about 1100-1200 mL, Inspiratory Reserve Volume is about 2500-3000 mL, and Tidal Volume is about 500 mL. This matches A-III, B-IV, C-I, D-II as the correct combination of respiratory volumes.

4. (1) A-II, B-I, C-IV, D-III
Aquatic molluscs respire through gills (branchial respiration). Reptiles use lungs only (pulmonary respiration). Adult amphibians respire through both lungs and skin (pulmonary and cutaneous). Amoeba, being unicellular, exchanges gases directly through its body surface by cellular respiration, giving A-II, B-I, C-IV, D-III.

5. (3) Physico-chemical approach to study and understand living organisms.
Reductionist biology involves studying complex biological systems by breaking them down into their simplest physical and chemical components. This approach aims to explain the properties of living organisms through the fundamental interactions of molecules and chemical processes. It provides a foundational understanding of life by focusing on the underlying molecular mechanisms and physical laws that govern biological functions.

6. (3) A-III, B-I, C-IV, D-II
Residual volume refers to the air remaining in the lungs after forceful expiration. Vital capacity is the maximum air volume breathed in following a forced expiration. Expiratory capacity represents the total air volume expired after a normal inspiration. Tidal volume is the volume of air inspired or expired during a normal respiratory cycle without any extra effort or force.

7. (1) A-II, B-IV, C-I, D-III
Expiratory capacity is the sum of tidal volume and expiratory reserve volume. Functional residual capacity combines expiratory reserve volume with residual volume. Vital capacity encompasses expiratory reserve, tidal, and inspiratory reserve volumes together. Inspiratory capacity specifically measures the total volume of air a person can inspire after a normal expiration by adding tidal and inspiratory reserve volumes together.

8. (3) Both A and R are true and R is the correct explanation of A.
Carbon dioxide binds to haemoglobin forming carbamino-haemoglobin for transport, accounting for nearly one-fourth of the total CO_2 carried in the blood. This binding process is highly sensitive to the partial pressures of gases. High carbon dioxide and low oxygen levels in tissues significantly promote this association, facilitating the efficient removal of metabolic waste from cells to the lungs.

9. (2) High pO_2 and Lesser H^+ concentration
The association of oxygen with haemoglobin to form oxyhaemoglobin occurs primarily in the lungs. This process is driven by specific alveolar conditions, including high oxygen partial pressure and low carbon dioxide levels. Additionally, a lower concentration of hydrogen ions and a cooler temperature in the alveolar environment significantly enhance the binding affinity of haemoglobin for oxygen molecules during respiration.

10. (1) (D), (A), (C), (B), (E)
Respiration involves a series of sequential physiological steps starting with pulmonary

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(4) B - Pleural membrane - Surround ribs on both sides to provide cushion against rubbing.

2012

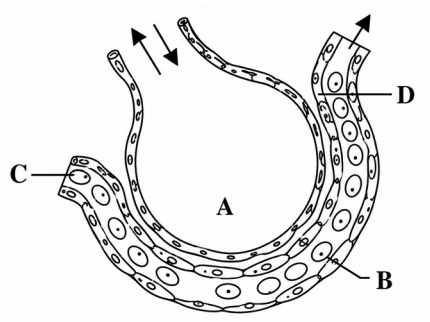
34. Which one of the following is the correct statement for respiration in humans?
(1) Cigarette smoking may lead to inflammation of bronchi.
(2) Neural signals from pneumotoxic centre in pons region of brain can increase the duration of inspiration.
(3) Workers in grinding and stone-breaking industries may suffer from lung fibrosis.
(4) About 90% of carbon dioxide (CO_2) is carried by haemoglobin as carbamino-haemoglobin.

Mains 2011

35. Which one of the following is a possibility for most of us in regard to breathing, by making a conscious effort?
(1) One can breathe out air totally without oxygen.
(2) One can breathe out air through Eustachian tube by closing both nose and mouth.
(3) One can consciously breathe in and breathe out by moving the diaphragm alone, without moving the ribs at all.
(4) The lungs can be made fully empty by forcefully breathing out all air from them.

2011

36. The figure given below shows a small part of human lung where exchange of gases takes place. Select the option which represents labelled part (A, B, C or D) correctly identified along with its function.



(1) C : Arterial capillary - Passes oxygen to tissues
(2) A : Alveolar cavity - Main site of exchange of respiratory gases
(3) D : Capillary wall - Exchange of O_2 and CO_2 takes place here
(4) B : Red blood cells - Transport of CO_2 mainly

2011

37. A large proportion of oxygen remains unused in the human blood even after its uptake by the body tissues. This O_2
(1) acts as a reserve during muscular exercise
(2) raises the pCO_2 of blood to 75 mm of Hg
(3) is enough to keep oxyhaemoglobin saturation at 96%
(4) helps in releasing more O_2 to the epithelial tissues.

Mains 2011

38. Bulk of carbon dioxide (CO_2) released from body tissues into the blood is present as
(1) bicarbonate in blood plasma and RBCs
(2) free CO_2 in blood plasma
(3) 70% carbamino-haemoglobin and 30% as bicarbonate
(4) carbamino-haemoglobin in RBCs.

2010

39. Listed below are four respiratory capacities (i-iv) and four jumbled respiratory volumes of a normal human adult.

	Respiratory capacities		**Respiratory volumes**
(i)	Residual volume	(A)	2500 mL
(ii)	Vital capacity	(B)	3500 mL
(iii)	Inspiratory reserve volume	(C)	1200 mL
(iv)	Inspiratory capacity	(D)	4500 mL

Which one of the following is the correct matching of two capacities and volumes?
(1) (ii) 2500 mL, (iii) 4500 mL
(2) (iii) 1200 mL, (iv) 2500 mL
(3) (iv) 3500 mL, (i) 1200 mL
(4) (i) 4500 mL, (ii) 3500 mL

2010

40. What is true about RBCs in humans?
(1) They carry about 20-25 percent of CO_2.
(2) They transport 99.5 percent of O_2.
(3) They transport about 80 percent oxygen only and the rest 20 percent of it is transported in dissolved state in blood plasma.
(4) They do not carry CO_2 at all.

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88. (1) seed germination

Gibberellins are essential for initiating the process of seed germination. They act by stimulating the production of hydrolytic enzymes, such as alpha-amylase, which break down stored food reserves in the seed. This provides the necessary energy and nutrients for the embryo to grow. By overcoming dormancy and promoting metabolic activity, gibberellins ensure the successful emergence of the seedling from its seed coat.

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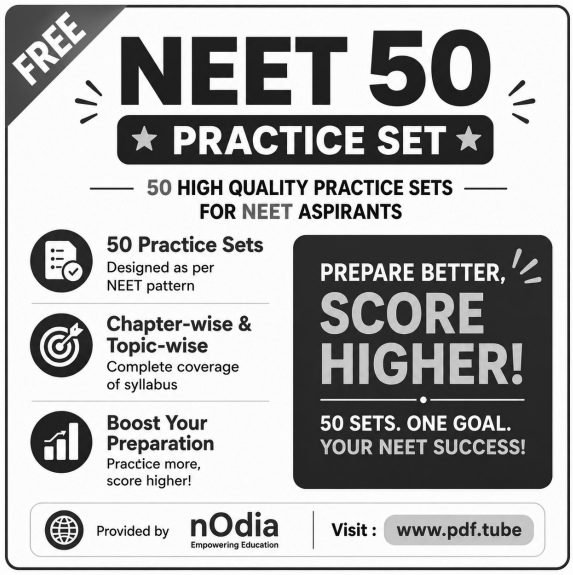

1996

53. How the transport of O_2 and CO_2 by blood happens?
(1) With the help of WBCs and blood serum
(2) With the help of platelets and corpuscles
(3) With the help of RBCs and blood plasma
(4) With the help of RBCs and WBCs

1995

54. The ventilation movements of the lungs in mammals are governed by
(1) muscular walls of lung
(2) diaphragm
(3) intercostal muscles
(4) both (b) and (c).

1995

55. At high altitude, the RBCs in the human blood will
(1) increase in number
(2) decrease in number
(3) increase in size
(4) decrease in size.

1995

56. Although much CO_2 is carried in blood, yet blood does not become acidic, because
(1) CO_2 is continuously diffused through the tissues and is not allowed to accumulate
(2) in CO_2 transport, blood buffers play an important role
(3) CO_2 is absorbed by the leucocytes
(4) CO_2 combines with water to form H_2CO_3 which is neutralised by $NaCO_3$.

1995

57. The carbon dioxide is transported via blood to lungs mostly
(1) in combination with haemoglobin only
(2) dissolved in blood plasma
(3) in the form of bicarbonate ions
(4) as carbamino-haemoglobin and as carbonic acid.

1994

58. In man and mammals, air passes from outside into the lungs through
(1) nasal cavity, larynx, pharynx, trachea, bronchi, alveoli
(2) nasal cavity, larynx, pharynx, trachea, bronchioles, alveoli
(3) nasal cavity, pharynx, larynx, trachea, bronchioles, bronchi, alveoli
(4) nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveoli.

1994

59. The respiratory centre which regulates respiration is located in
(1) cerebellum
(2) medulla oblongata
(3) cerebral peduncle
(4) the vagus nerve.

1993

60. Carbon dioxide is transported from tissues to respiratory surface by only
(1) plasma and erythrocytes
(2) plasma
(3) erythrocytes
(4) erythrocytes and leucocytes.

1991

61. Carbonic anhydrase occurs in
(1) lymphocytes
(2) blood plasma
(3) RBCs
(4) leucocytes.

1990

62. Skin is an accessory organ of respiration in
(1) humans
(2) frog
(3) rabbit
(4) lizard.

1990

63. The alveolar epithelium in the lung is
(1) non-ciliated columnar
(2) non-ciliated squamous
(3) ciliated columnar
(4) ciliated squamous.

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2018

23. Which of the following is an occupational respiratory disorder?
(1) Anthracis
(2) Silicosis
(3) Botulism
(4) Emphysema

2017

24. Lungs are made up of air-filled sacs, the alveoli. They do not collapse even after forceful expiration, because of
(1) inspiratory reserve volume
(2) tidal volume
(3) expiratory reserve volume
(4) residual volume.

NEET-II 2016

25. Lungs do not collapse between breaths and some air always remains in the lungs which can never be expelled because
(1) there is a negative pressure in the lungs
(2) there is a negative intrapleural pressure pulling at the lung walls
(3) there is a positive intrapleural pressure
(4) pressure in the lungs is higher than the atmospheric pressure.

NEET-II 2016

26. The partial pressure of oxygen in the alveoli of the lungs is
(1) equal to that in the blood
(2) more than that in the blood
(3) less than that in the blood
(4) less than that of carbon dioxide.

NEET-I 2016

27. Reduction in pH of blood will
(1) decrease the affinity of haemoglobin with oxygen
(2) release bicarbonate ions by the liver
(3) reduce the rate of heartbeat
(4) reduce the blood supply to the brain.

NEET-I 2016

28. Name the chronic respiratory disorder caused mainly by cigarette smoking.
(1) Respiratory acidosis
(2) Respiratory alkalosis
(3) Emphysema
(4) Asthma

NEET-I 2016

29. Asthma may be attributed to
(1) inflammation of the trachea
(2) accumulation of fluid in the lungs
(3) bacterial infection of the lungs
(4) allergic reaction of the x in the lungs.

2015 Cancelled

30. When you hold your breath, which of the following gas changes in blood would first lead to the urge to breathe?
(1) Falling CO_2 concentration
(2) Rising CO_2 and falling O_2 concentration
(3) Falling O_2 concentration
(4) Rising CO_2 concentration

2015

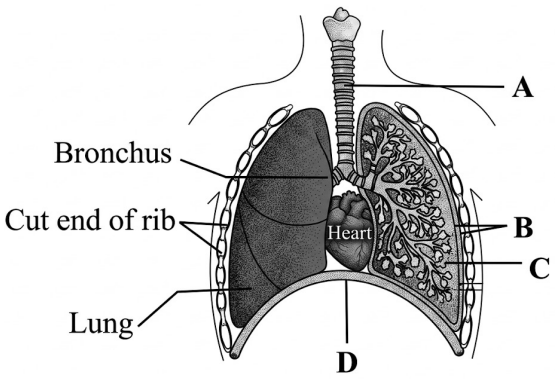
31. Name the pulmonary disease in which alveolar surface area involved in gas exchange is drastically reduced due to damage in the alveolar walls.
(1) Pneumonia
(2) Asthma
(3) Pleurisy
(4) Emphysema

2014

32. Approximately seventy percent of carbon dioxide absorbed by the blood will be transported to the lungs
(1) as bicarbonate ions
(2) in the form of dissolved gas molecules
(3) by binding to RBC
(4) as carbamino - haemoglobin.

2013

33. The figure shows a diagrammatic view of human respiratory system with labels A, B, C and D. Select the option which gives correct identification and main function and / or characteristic.



(1) C - Alveoli - Thin walled vascular bag-like structures for exchange of gases.
(2) D - Lower end of lungs - Diaphragm pulls it down during inspiration.
(3) A - Trachea - Long tube supported by complete cartilaginous rings for conducting inspired air.

ventilation to exchange atmospheric and alveolar air. This is followed by gas diffusion across the alveolar membrane and transport through the bloodstream. Finally, gases diffuse between the blood and tissues, allowing cells to utilize oxygen for catabolic reactions while simultaneously releasing carbon dioxide as waste into the circulating blood.

11. (2) IRV + ERV + TV
Vital capacity represents the maximum volume of air an individual can breathe out after a forceful inspiration. It is calculated by summing the inspiratory reserve volume, the tidal volume, and the expiratory reserve volume. This measurement excludes the residual volume, as that air cannot be expelled from the lungs even with the most strenuous expiratory effort during the breathing process.

12. (4) Provides surface for diffusion of O_2 and CO_2
The conducting portion of the respiratory system includes structures from the external nostrils to the terminal bronchioles. Its primary roles involve transporting atmospheric air to the alveoli, clearing it of foreign particles, humidifying it, and regulating its temperature. However, the actual exchange of gases through diffusion occurs only in the respiratory or exchange part, specifically within the thin alveolar walls.

13. (2) 5 mL
Haemoglobin in the blood binds with oxygen in the lungs to form oxyhaemoglobin. During circulation, this oxygen is released to the tissues based on metabolic demands. Under standard physiological conditions, every hundred millilitres of oxygenated blood typically releases about five millilitres of oxygen to the body tissues. This efficient delivery system ensures that cells receive adequate oxygen for energy production.

14. (2) $pO_2 = 104$ and $pCO_2 = 40$
Gas exchange in the lungs occurs via simple diffusion driven by partial pressure gradients. In the alveoli, the partial pressure of oxygen is maintained at approximately one hundred and four millimetres of mercury. Simultaneously, the partial pressure of carbon dioxide in the alveolar air is about forty millimetres of mercury. These specific values facilitate the movement of gases between air and blood.

15. (2) High pO_2, low pCO_2, less H^+, lower temperature
The formation of oxyhaemoglobin in the lungs is highly dependent on the surrounding chemical environment. High partial pressure of oxygen in the alveoli encourages binding. Simultaneously, low partial pressure of carbon dioxide, reduced hydrogen ion concentration, and lower temperature further increase the affinity of haemoglobin for oxygen. These conditions ensure efficient oxygen uptake from the lungs into the blood circulation.

16. (1) (1) and (2)
Inspiration is an active process initiated by the contraction of the diaphragm, which increases the thoracic volume in the antero-posterior axis. Concurrently, the external intercostal muscles contract, lifting the ribs and sternum to expand the thoracic chamber in the dorso-ventral axis. These combined movements lead to an increase in pulmonary volume, which subsequently decreases the intrapulmonary pressure, allowing atmospheric air to flow into the respiratory system.

17. (3) Higher H^+ conc. in alveoli favours the formation of oxyhaemoglobin.
Oxygen binds with haemoglobin primarily based on the partial pressure of oxygen. However, other factors like the partial pressure of carbon dioxide and hydrogen ion concentration also influence this process. In the alveoli, low carbon dioxide levels and low hydrogen ion concentrations promote oxyhaemoglobin formation. Conversely, high hydrogen ion levels or increased acidity in the tissues promote oxygen dissociation.

18. (2) 1500 mL
Expiratory capacity is defined as the total volume of air a person can expire after a normal inspiration. It is calculated by adding the tidal volume to the expiratory reserve volume. For an athlete with a tidal volume of five hundred millilitres and an expiratory reserve volume of one thousand millilitres, the resulting expiratory capacity equals fifteen hundred millilitres, regardless of residual volume.

19. (2) Intrapulmonary pressure is lower than the atmospheric pressure during inspiration.
Respiration is driven by pressure gradients between the atmosphere and the lungs. Inspiration occurs when the intrapulmonary

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2024

9. Match List I with List II.

List I (ECG Components)		List II (Events)	
A.	P wave	I.	Heart muscles are electrically silent
B.	QRS complex	II.	Depolarisation of ventricles
C.	T wave	III.	Depolarisation of atria
D.	T-P gap	IV.	Repolarisation of ventricles.

Choose the correct answer from the options given below.
(1) A-I, B-III, C-IV, D-II
(2) A-III, B-II, C-IV, D-I
(3) A-II, B-III, C-I, D-IV
(4) A-IV, B-II, C-I, D-III

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10. Match List I with List II.

List I (Types of WBCs)		List II (Percentage in Blood)	
(A)	Eosinophils	(I)	6 - 8%
(B)	Lymphocytes	(II)	2 - 3%
(C)	Neutrophils	(III)	20 - 25%
(D)	Monocytes	(IV)	60 - 65 %

Choose the correct answer from the options given below.
(1) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)
(2) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)
(3) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
(4) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

2023

11. Which of the following statements are correct?
A. Basophils are most abundant cells of the total WBCs.
B. Basophils secrete histamine, serotonin and heparin.
C. Basophils are involved in inflammatory response.
D. Basophils have kidney-shaped nucleus.
E. Basophils are agranulocytes.
Choose the correct answer from the options given below.
(1) B and C only
(2) A and B only
(3) D and E only
(4) C and E only

Manipur NEET 2023

12. Match List I with List II.

List I (ECG)		List II (Electrical activity of heart)	
(A)	P-wave	(I)	Depolarisation of ventricles
(B)	QRS complex	(II)	End of systole
(C)	T wave	(III)	Depolarisation of atria
(D)	End of T wave	(IV)	Repolarisation of ventricles

Choose the correct answer from the options given below.
(1) (A)-(IV), (B)-(I), (C)-(III), (D)-(II)
(2) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)
(3) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)
(4) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

2023

13. Match List I with List II.

List I (ECG Components)			List II (Events)
A.	P-wave	I.	Beginning of systole
B.	Q-wave	II.	Repolarisation of ventricles
C.	QRS complex	III.	Depolarisation of atria
D.	T-wave	IV.	Depolarisation of ventricles

Choose the correct answer from the options given below.
(1) A-II, B-IV, C-I, D-III
(2) A-I, B-II, C-III, D-IV
(3) A-III, B-I, C-IV, D-II
(4) A-IV, B-III, C-II, D-I

2023

14. Cardiac activities of the heart are regulated by:
A. Nodal tissue
B. A special neural centre in the medulla oblongata
C. Adrenal medullary hormones
D. Adrenal cortical hormones
Choose the correct answer from the options given below:
(1) A, C and D only
(2) A, B and D only
(3) A, B and C only
(4) A, B, C and D

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damage the delicate walls of the alveoli. This destruction reduces the overall surface area for gas exchange, making breathing increasingly difficult. It is classified as a chronic obstructive pulmonary disease due to its permanent impact on lung structure.

29. (4) allergic reaction of the x in the lungs.
Asthma is a respiratory disorder characterized by sudden attacks of breathlessness and wheezing. These symptoms are caused by an allergic reaction of the bronchi and bronchioles. Such triggers cause the smooth muscles of the bronchi and bronchioles to spasm and become inflamed. This narrowing of the airways restricts airflow, leading to the clinical manifestations of the condition.

30. (4) Rising CO_2 concentration
The urge to breathe is primarily controlled by the respiratory centre in the brain, which is highly sensitive to chemical changes in the blood. When you hold your breath, carbon dioxide levels rise due to continued cellular metabolism. This increase in carbon dioxide concentration, rather than a lack of oxygen, is the primary stimulus that triggers the reflex to inhale air.

31. (4) Emphysema
Emphysema is a chronic pulmonary condition where the walls of the alveoli become damaged and eventually break down. This structural damage results in the formation of larger, fewer air sacs, which drastically reduces the total surface area available for the diffusion of gases. As a result, the efficiency of gas exchange is significantly impaired, leading to persistent shortness of breath in individuals.

32. (1) as bicarbonate ions
Carbon dioxide is transported in the blood in three main ways. A small portion is dissolved in plasma, and some binds directly to haemoglobin. However, the majority of carbon dioxide, approximately seventy percent, is converted into bicarbonate ions. This transformation occurs within red blood cells with the help of the enzyme carbonic anhydrase before the ions enter the blood plasma.

33. (1) C - Alveoli - Thin walled vascular bag-like structures for exchange of gases.
Alveoli are the primary sites of gas exchange in the human respiratory system. They are characterized as very thin-walled, vascularized, bag-like structures that provide an extensive surface area for the diffusion of oxygen and carbon dioxide. This structural design ensures efficient transfer between the inhaled air and the blood circulating in the surrounding pulmonary capillaries, supporting vital metabolic processes within the body.

34. (3) Workers in grinding and stone-breaking industries may suffer from lung fibrosis.
Workers in industries such as stone breaking or grinding are frequently exposed to high levels of mineral dust. Prolonged inhalation of these particles leads to chronic inflammation and the subsequent development of fibrosis in the lung tissues. Fibrosis involves the excessive growth of connective tissue, which eventually impairs lung function. This condition is categorized as an occupational respiratory disorder affecting long-term health.

35. (3) One can consciously breathe in and breathe out by moving the diaphragm alone, without moving the ribs at all.
Although breathing is typically an involuntary process regulated by the brain, it can be consciously influenced to a certain extent. An individual can intentionally control the movements of the diaphragm to breathe in and out without significantly moving the ribs or chest wall. However, one cannot completely empty the lungs of all air or breathe effectively solely through the Eustachian tubes.

36. (2) A : Alveolar cavity - Main site of exchange of respiratory gases
The alveolar cavity serves as the primary anatomical site for the exchange of respiratory gases between the atmosphere and the body. Its wall is extremely thin, consisting of a single layer of squamous epithelial cells. This minimal thickness, combined with a large surface area, allows for the efficient simple diffusion of oxygen into the blood and carbon dioxide out during respiration.

37. (1) acts as a reserve during muscular exercise
During normal resting conditions, the blood does not release all of its carried oxygen to the tissues. A significant proportion of oxygen remains bound to haemoglobin even after the blood has circulated through the body. This remaining oxygen serves as a vital physiological reserve that

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57. (3) in the form of bicarbonate ions
Carbon dioxide is transported from the tissues to the lungs in several different forms. While about twenty percent binds to haemoglobin and seven percent dissolves in plasma, the majority, approximately seventy percent, is carried as bicarbonate ions. This primary method involves the conversion of carbon dioxide into bicarbonate within red blood cells, which then diffuses into the plasma for transport.

58. (4) nasal cavity, pharynx, larynx, trachea, bronchi, bronchioles, alveoli.
During inhalation, air follows a specific anatomical pathway to reach the site of gas exchange. It enters through the nasal cavity, passes through the pharynx and larynx, and then travels down the trachea. From the trachea, the air moves into the bronchi, which branch into smaller bronchioles, and finally reaches the tiny air sacs known as the alveoli within the lungs.

59. (2) medulla oblongata
The fundamental rhythm of breathing is controlled by the respiratory rhythm centre. This specialized group of neurons is located in the medulla oblongata of the brain. It is responsible for generating the basic signals that stimulate the muscles involved in inspiration and expiration. By monitoring chemical changes in the blood, this centre adjusts the breathing rate to maintain homeostasis.

60. (1) plasma and erythrocytes
Carbon dioxide transport from the body's tissues to the respiratory surfaces depends exclusively on the components of the blood. It is carried in the plasma as dissolved gas or bicarbonate ions and within the erythrocytes as carbamino-haemoglobin or as part of the bicarbonate reaction. This collaborative effort between plasma and red blood cells ensures that metabolic waste is efficiently removed.

61. (3) RBCs
Carbonic anhydrase is a vital enzyme that facilitates the rapid conversion of carbon dioxide and water into carbonic acid. This enzyme is found in extremely high concentrations within the red blood cells, although minute quantities also exist in the plasma. Its presence in erythrocytes is crucial for the efficient transport of carbon dioxide in the form of bicarbonate ions throughout the bloodstream.

62. (2) frog
While most vertebrates rely primarily on lungs for respiration, some animals use additional organs to supplement gas exchange. For example, frogs are capable of cutaneous respiration, where oxygen and carbon dioxide are exchanged directly through their thin, moist skin. This accessory method is especially important when the frog is underwater or during periods of hibernation when lung use is kept minimal.

63. (2) non-ciliated squamous
The alveoli are the functional units of the lungs where the exchange of oxygen and carbon dioxide occurs. To facilitate efficient diffusion, the alveolar wall is lined with a very thin, single layer of non-ciliated squamous epithelial cells. This simple squamous epithelium provides a minimal barrier between the air and the blood capillaries, maximizing the rate of gas transfer across the membrane.

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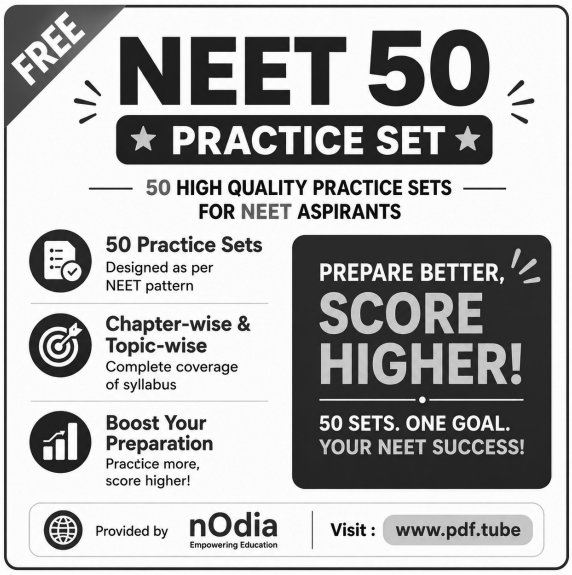

47. (2) respiratory pigment
Haemoglobin is a complex iron-containing protein found within the red blood cells of vertebrates. It functions as a specialized respiratory pigment because of its unique ability to reversibly bind with oxygen and carbon dioxide. This property allows it to transport oxygen from the respiratory organs to the rest of the body and return carbon dioxide back to the lungs for elimination.

48. (2) medulla oblongata
The involuntary control of breathing is managed by specialized neural clusters known as respiratory centres. These centres are primarily located in the medulla oblongata of the brainstem. They regulate the rhythm and depth of respiration by sending signals to the diaphragm and intercostal muscles, ensuring that the body's gas exchange requirements are met under various physiological and metabolic conditions.

49. (4) simple diffusion.
Gas exchange between the alveolar air and the blood in the pulmonary capillaries occurs through a physical process called simple diffusion. This movement is entirely passive and is driven by the partial pressure gradients of oxygen and carbon dioxide. Gases move from an area of higher partial pressure to an area of lower partial pressure across the thin respiratory membrane easily.

50. (2) squamous epithelium + endothelium of blood vessel
The respiratory membrane, where gas exchange occurs, is incredibly thin to facilitate rapid diffusion. It is composed of three main layers: the thin squamous epithelium of the alveoli, the endothelium of the surrounding pulmonary capillaries, and the basement membrane between them. This structure separates the air in the lungs from the venous blood, allowing oxygen and carbon dioxide to pass efficiently.

51. (4) pleural membrane.
The human lungs are situated within the thoracic cavity and are protected by a double-layered serous membrane known as the pleura or pleural membrane. The outer layer adheres to the thoracic wall, while the inner layer covers the lung surface. The small space between these layers contains pleural fluid, which reduces friction and allows the lungs to expand smoothly during respiration.

52. (1) residual volume
Residual volume is the amount of air that remains in the lungs even after a person performs a maximal forceful expiration. Standard values are typically around twelve hundred millilitres, although variations occur based on individual physiology. This air ensures that the lungs do not collapse and that gas exchange continues between breaths.

53. (3) With the help of RBCs and blood plasma
The transport of respiratory gases throughout the body involves both the cellular and liquid components of blood. Oxygen is primarily carried by the haemoglobin inside red blood cells, with a small amount dissolved in plasma. Carbon dioxide is transported in three ways: as bicarbonate ions in the plasma, bound to haemoglobin in red cells, or dissolved directly in the plasma fluid.

54. (4) both (b) and (c).
Breathing or pulmonary ventilation is a mechanical process that changes the volume of the thoracic cavity to create pressure gradients. This movement is primarily governed by the contraction and relaxation of the diaphragm and the intercostal muscles located between the ribs. Together, these muscles coordinate the expansion and contraction of the lungs, facilitating the regular inflow and outflow of air.

55. (1) increase in number
At high altitudes, the atmospheric pressure is lower, which results in a decrease in the partial pressure of oxygen. To compensate for the reduced oxygen availability, the human body stimulates the production of more red blood cells through a process called erythropoiesis. Increasing the number of these cells enhances the blood's capacity to bind and transport limited oxygen to tissues.

56. (2) in CO_2 transport, blood buffers play an important role
Even though large amounts of carbon dioxide are transported in the blood, the overall pH remains relatively stable. This stability is maintained by various blood buffers, which neutralize the acidity generated when carbon dioxide reacts with water. Bicarbonate ions and proteins like haemoglobin act as effective buffers, preventing the blood from becoming dangerously acidic during the transport of metabolic waste.

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can be immediately utilized during periods of increased physical activity or strenuous muscular exercise in humans.

38. (1) bicarbonate in blood plasma and RBCs
Carbon dioxide generated by tissues enters the bloodstream and undergoes various chemical reactions for transport. The largest portion of this gas is carried in the form of bicarbonate ions. This process occurs as carbon dioxide reacts with water inside red blood cells to form carbonic acid, which then dissociates into bicarbonate and hydrogen ions, moving freely into the blood plasma.

39. (3) (iv) 3500 mL, (i) 1200 mL
Inspiratory capacity is the total volume of air inhalable after normal expiration, typically measuring about thirty-five hundred millilitres. Residual volume is the amount of air that remains in the lungs even after the most forceful expiration, which is approximately twelve hundred millilitres. These measurements are crucial for assessing pulmonary function and understanding the various capacities of the human respiratory system accurately.

40. (1) They carry about 20-25 percent of CO_2.
Red blood cells play a dual role in gas transport within the human body. While they are primarily known for carrying oxygen, they also transport a significant portion of carbon dioxide. Approximately twenty to twenty-five percent of the carbon dioxide produced by tissues binds to the globin part of haemoglobin, forming carbamino-haemoglobin, which is then carried back to the lungs for expiration.

41. (2) Total lung capacity minus residual volume
Vital capacity is a key indicator of pulmonary health and represents the maximum amount of air a person can expel from the lungs after a maximum inhalation. It can be calculated by subtracting the residual volume from the total lung capacity. This measurement includes the tidal volume, the inspiratory reserve volume, and the expiratory reserve volume, reflecting overall lung flexibility and strength.

42. (2) has a higher affinity for oxygen than that of an adult
Fetal haemoglobin has a distinct molecular structure compared to adult haemoglobin, allowing it to function effectively in the low-oxygen environment of the womb. It possesses a much higher affinity for oxygen, which enables the fetus to successfully extract oxygen from the mother's blood across the placenta. This physiological adaptation is critical for ensuring adequate oxygenation for the developing fetus during pregnancy.

43. (4) In insects, circulating body fluids serve to distribute oxygen to tissues.
In the insect respiratory system, oxygen is delivered directly to the tissues through a complex network of tubes called tracheae. Unlike mammals or fish, insects do not rely on their circulating body fluid, or haemolymph, to distribute oxygen. Instead, air enters through spiracles and travels through tracheal branches to reach every cell, making gas transport independent of the circulatory system components.

44. (3) bicarbonates
Carbon dioxide produced during cellular metabolism is transported to the lungs in three different forms. While some is dissolved in plasma and some binds to haemoglobin, the vast majority is carried as bicarbonate ions. This conversion occurs primarily within red blood cells, facilitated by the enzyme carbonic anhydrase, which helps maintain the acid-base balance of the blood during the transport process.

45. (4) carbon monoxide.
Carbon monoxide is a highly toxic gas because it has a much higher affinity for haemoglobin than oxygen does. When inhaled, it binds tightly to haemoglobin to form a stable complex called carboxyhaemoglobin. This significantly reduces the blood's ability to carry oxygen to vital organs. High levels of this complex indicate exposure to polluted air containing concentrated carbon monoxide gas.

46. (4) faster and deeper.
The body's respiratory rate is closely monitored by chemoreceptors that are sensitive to changes in blood chemistry. When the concentration of carbon dioxide in the blood increases, it leads to a drop in pH. To compensate and remove the excess gas, the brain sends signals to increase the depth and frequency of breathing, making the respiratory movements both faster and deeper.

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CHAPTER 15

Body Fluids and Circulation

2026 (RE-NEET)

1. Which of the following statements is incorrect?
(1) Fibrin is produced from fibrinogen
(2) Fibrinogen is produced from fibrin
(3) Blood coagulates in response to an injury
(4) Blood clot consists of fibrins

2026 (RE-NEET)

2. The number of action potentials generated by sino-atrial node (SAN) in a healthy human is ___ per minute.
(1) 100-110 (2) 120-140
(3) 28-30 (4) 70-75

2026 (RE-NEET)

3. The opening between the right atrium and the right ventricle is guarded by ___.
(1) semilunar valve
(2) sino-atrial node
(3) bicuspid valve
(4) tricuspid valve

2026 (CANCELLED)

4. The WBC count of a person's blood sample is 8000/cu.mm. How many eosinophils and lymphocytes would be in the same blood sample approximately?
(1) 300-500/cu.mm and 1200-1500/cu.mm, respectively
(2) 160-240/cu.mm and 1600-2000/cu.mm, respectively
(3) 300-500/cu.mm and 500-700/cu.mm, respectively
(4) 100-120/cu.mm and 160-200/cu.mm, respectively

2026 (CANCELLED)

5. Select the INCORRECT statements with reference to Rh grouping:
A. Erythroblastosis foetalis is a condition observed having foetus with Rh+ve blood and mother with Rh-ve blood.
B. Rh antigen is observed on RBCs in the majority of human beings.
C. Before blood transfusion, Rh group should also be matched.
D. Rh incompatibility is observed when a pregnant mother is Rh+ve and the foetus is Rh-ve.
E. Erythroblastosis foetalis can be avoided by administering anti-Rh antibodies to the mother immediately after the delivery of the second child.
Choose the answer from the options given below:
(1) C and D only
(2) A and B only
(3) A and E only
(4) D and E only

RE-EXAM 2024

6. A person with blood group A Rh^- can receive the blood transfusion from which of the following types?
A. B Rh^-
B. AB Rh^-
C. O Rh^-
D. A Rh^-
E. A RH^+
Choose the correct answer from the options given below.
(1) D and E only
(2) D only
(3) A and B only
(4) C and D only

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RE-EXAM 2024

7. 'Lub' sound of heart is caused by the _____.
(1) closure of the semilunar valves
(2) opening of tricuspid and bicuspid valves
(3) opening of the semilunar valves
(4) closure of the tricuspid and bicuspid valves

2024

8. Following are the stages of pathway for conduction of an action potential through the heart.
A. AV bundle
B. Purkinje fibres
C. AV node
D. Bundle branches
E. SA node
Choose the correct sequences of pathways from the options given below.
(1) E-C-A-D-B (2) A-E-C-B-D
(3) B-D-E-C-A (4) E-A-D-B-C

pressure becomes lower than the atmospheric pressure, creating a negative pressure that draws air inside. Conversely, expiration happens when the intrapulmonary pressure exceeds atmospheric levels. These pressure changes are primarily controlled by the diaphragm and the intercostal muscles during the active breathing cycle.

20. (3) inflammation of bronchi and bronchioles
Asthma is a chronic respiratory condition often triggered by allergens or environmental pollutants. It is characterized by the inflammation of the bronchi and bronchioles within the lungs. This inflammatory response leads to the narrowing of the airways and excess mucus production, which results in difficult breathing and a characteristic whistling sound, commonly known as wheezing, during the human respiratory process.

21. (2) (iii) (i) (iv) (ii)
Tidal volume represents air moved during normal breathing, typically five hundred millilitres. Inspiratory reserve volume is extra air inhalable forcibly, ranging from twenty-five hundred to three thousand millilitres. Expiratory reserve volume is extra air exhalable forcibly, usually eleven hundred millilitres. Residual volume is air remaining after forced exhalation, approximately twelve hundred millilitres. These volumes are vital indicators of pulmonary function.

22. (1) Inflammation of bronchioles; Decreased respiratory surface
Asthma and emphysema are distinct respiratory disorders with different underlying causes. Asthma involves the hypersensitivity and inflammation of the bronchi and bronchioles, which restricts airflow. Emphysema is a chronic condition often caused by smoking, where the alveolar walls are damaged. This destruction leads to a significant decrease in the total surface area available for gas exchange within the human respiratory system.

23. (2) Silicosis
Certain industries involving stone breaking or grinding expose workers to excessive dust, leading to occupational respiratory disorders. Prolonged exposure can overwhelm the body's defense mechanisms, causing serious lung inflammation. This inflammatory process eventually leads to fibrosis, which is the proliferation of fibrous connective tissue. Silicosis is a well-known example of such a disease resulting from inhaling fine silica dust particles.

24. (4) residual volume.
Even after the most forceful expiration, the lungs never completely empty of air. The specific volume of air that remains trapped within the lungs is known as the residual volume. This constant presence of air provides enough internal pressure to prevent the delicate alveolar sacs from collapsing. It ensures that gas exchange can continue uninterrupted between consecutive breaths during the respiration process.

25. (2) there is a negative intrapleural pressure pulling at the lung walls
The lungs stay inflated due to the pressure difference between the internal pulmonary space and the pleural cavity. A negative intrapleural pressure relative to the atmospheric pressure exists within the thoracic cage. This negative pressure exerts a pulling force on the lung walls, keeping them expanded against the chest wall. Consequently, some air, termed residual volume, always remains inside the lungs.

26. (2) more than that in the blood
Gas exchange in the respiratory system occurs through simple diffusion along a concentration gradient. For oxygen to move from the lungs into the bloodstream, its partial pressure in the alveoli must be higher than in the deoxygenated blood entering the pulmonary capillaries. This pressure difference ensures that oxygen molecules naturally flow into the blood to be transported to the body tissues.

27. (1) decrease the affinity of haemoglobin with oxygen
A reduction in blood pH indicates an increase in acidity, often caused by higher carbon dioxide levels. This chemical change alters the structure of haemoglobin, reducing its affinity for oxygen molecules. Consequently, oxygen is released more readily from haemoglobin to the tissues. This phenomenon, known as the Bohr effect, is essential for delivering oxygen to metabolically active cells throughout the body.

28. (3) Emphysema
Emphysema is a long-term, progressive lung disease primarily associated with chronic cigarette smoking. The toxic chemicals in smoke cause persistent inflammation and eventually

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2022

15. Given below are two statements.
Statement I: The coagulum is formed of network of threads called thrombins.
Statement II: Spleen is the graveyard of erythrocytes.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Both statement I and statement II are correct.
(2) Both statement I and statement II are incorrect.
(3) Statement I is correct but statement II is incorrect.
(4) Statement I is incorrect but statement II is correct.

2022

16. Which one of the following statements is correct ?
(1) The atrio-ventricular node (AVN) generates an action potential to stimulate atrial contraction.
(2) The tricuspid and the bicuspid valves open due to the pressure exerted by the simultaneous contraction of the atria.
(3) Blood moves freely from atrium to the ventricle during joint diastole.
(4) Increased ventricular pressure causes closing of the semilunar valves.

2021

17. Persons with 'AB' blood group are called as "Universal recipients". This is due to
(1) absence of antibodies, anti-A and anti-B, in plasma
(2) absence of antigens A and B on the surface of RBCs
(3) absence of antigens A and B in plasma
(4) presence of antibodies, anti-A and anti-B, on RBCs.

2021

18. Which enzyme is responsible for the conversion of inactive fibrinogens to fibrins?
(1) Thrombokinase
(2) Thrombin
(3) Renin
(4) Epinephrine

2020

19. Match the following columns and select the correct option.

Column-I (WBC Type)		Column - II (Functions)	
(A)	Eosinophils	(i)	Immune response
(B)	Basophils	(ii)	Phagocytosis
(C)	Neutrophils	(iii)	Release histaminase, destructive enzymes
(D)	Lymphocytes	(iv)	Release granules containing histamine

(1) (A)-(iii); (B)-(iv); (C)-(ii); (D)-(i)
(2) (A)-(iv); (B)-(i); (C)-(ii); (D)-(iii)
(3) (A)-(i); (B)-(ii); (C)-(iv); (D)-(iii)
(4) (A)-(ii); (B)-(i); (C)-(iii); (D)-(iv)

2020

20. The QRS complex in a standard ECG represents
(1) repolarisation of auricles
(2) depolarisation of auricles
(3) depolarisation of ventricles
(4) repolarisation of ventricles.

2019

21. Match the column - I with column - II.

Column-I (ECG Features)		Column-II (Events/Conditions)	
(A)	P-wave	(i)	Depolarisation of ventricles
(B)	QRS complex	(ii)	Repolarisation of ventricles
(C)	T-wave	(iii)	Coronary ischaemia
(D)	Reduction in the size of T-wave	(iv)	Depolarisation of atria
		(v)	Repolarisation of atria

Select the correct option.
(1) (A)-(ii); (B)-(iii); (C)-(v); (D)-(iv)
(2) (A)-(iv); (B)-(i); (C)-(ii); (D)-(iii)
(3) (A)-(iv); (B)-(i); (C)-(ii); (D)-(v)
(4) (A)-(ii); (B)-(i); (C)-(v); (D)-(iii)

2019

22. What would be the heart rate of a person if the cardiac output is 5 L, blood volume in the ventricles at the end of diastole is 100 mL and at the end of ventricular systole is 50 mL ?
(1) 125 beats per minute
(2) 50 beats per minute

NODIA

(3) 75 beats per minute
(4) 100 beats per minute

2018

23. Match the items given in column I with those in column II and select the correct option given below.

Column I (Plasma Proteins)		Column II (Functions)	
A.	Fibrinogen	(i)	Osmotic balance
B.	Globulin	(ii)	Blood clotting
C.	Albumin	(iii)	Defence mechanism

(1) A-(iii); B-(ii); C-(i)
(2) A-(i); B-(ii); C-(iii)
(3) A-(i); B-(iii); C-(ii)
(4) A-(ii); B-(iii); C-(i)

2018

24. Match the items given in column I with those in column II and select the correct option given below.

	Column I (Heart Valves)		Column II (Location)
A.	Tricuspid valve	(i)	Between left atrium and left ventricle
B.	Bicuspid valve	(ii)	Between right ventricle and pulmonary artery
C.	Semilunar valve	(iii)	Between right atrium and right ventricle

(1) A-(iii); B-(i); C-(ii)
(2) A-(i); B-(iii); C-(ii)
(3) A-(i); B-(ii); C-(iii)
(4) A-(ii); B-(i); C-(iii)

2017

25. Adult human RBCs are enucleate. Which of the following statement(s) is/are most appropriate explanation for this feature?
A. They do not need to reproduce.
B. They are somatic cells.
C. They do not metabolise.
D. All their internal space is available for oxygen transport.
(1) Only (A)
(2) (A), (C) and (D)
(3) (B) and (C)
(4) Only (D)

2017

26. The hepatic portal vein drains blood to liver from
(1) stomach (2) kidneys
(3) intestine (4) heart.

NEET-II 2016

27. Name the blood cells, whose reduction in number can cause clotting disorder, leading to excessive loss of blood from the body.
(1) Erythrocytes (2) Leucocytes
(3) Neutrophils (4) Thrombocytes

NEET-II 2016

28. Serum differs from blood in
(1) lacking globulins
(2) lacking albumins
(3) lacking clotting factors
(4) lacking antibodies.

NEET-I 2016

29. Blood pressure in the pulmonary artery is
(1) more than that in the pulmonary vein
(2) less than that in the venae cavae
(3) same as that in the aorta
(4) more than that in the carotid.

NEET-I 2016

30. In mammals, which blood vessel would normally carry largest amount of urea?
(1) Hepatic vein
(2) Hepatic portal vein
(3) Renal vein
(4) Dorsal aorta

2015 Cancelled

31. Erythropoiesis starts in
(1) spleen
(2) red bone marrow
(3) kidney
(4) liver.

2015 Cancelled

32. Which one of the following is correct?
(1) Lymph = Plasma + RBC + WBC
(2) Blood = Plasma + RBC + WBC + Platelets
(3) Plasma = Blood – Lymphocytes
(4) Serum = Blood + Fibrinogen

2015

33. Doctors use stethoscope to hear the sounds produced during each cardiac cycle. The second sound is heard when
(1) AV node receives signal from SA node
(2) AV valves open up

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(3) Ventricular walls vibrate due to gushing in of blood from atria
(4) Semilunar valves close down after the blood flows into vessels from ventricles.

2015 Cancelled

34. Blood pressure in the mammalian aorta is maximum during
(1) systole of the left ventricle
(2) diastole of the right atrium
(3) systole of the left ventricle
(4) diastole of the right ventricle.

2015

35. Which one of the following animals has two separate circulatory pathways?
(1) Whale (2) Shark
(3) Frog (4) Lizard

2014

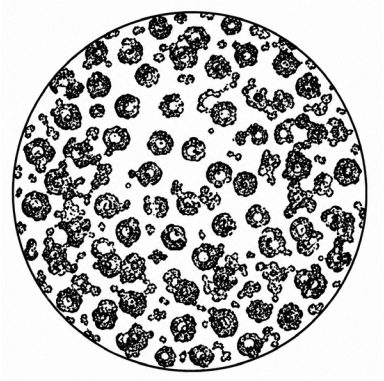
36. Person with blood group AB is considered as universal recipient because he has
(1) both A and B antigens on RBC but no antibodies in the plasma
(2) both A and B antibodies in the plasma
(3) no antigen on RBC and no antibody in the plasma
(4) both A and B antigens in the plasma but no antibodies.

2014

37. How do parasympathetic neural signals affect the working of the heart?
(1) Reduce both heart rate and cardiac output.
(2) Heart rate is increased without affecting the cardiac output.
(3) Both heart rate and cardiac output increase.
(4) Heart rate decreases but cardiac output increases.

Karnataka NEET 2013

38. The figure shows a human blood cell. Identify it and give its characteristics.



	Blood cell	Characteristics
(1)	Basophil	Secretes serotonin, inflammatory response
(2)	B-lymphocyte	Forms about 20% of blood cells involved in immune response
(3)	Neutrophil	Most abundant blood cells, phagocytic
(4)	Monocyte	Lifespan of 3 days, produces antibodies

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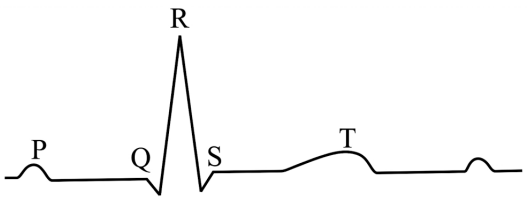
2013

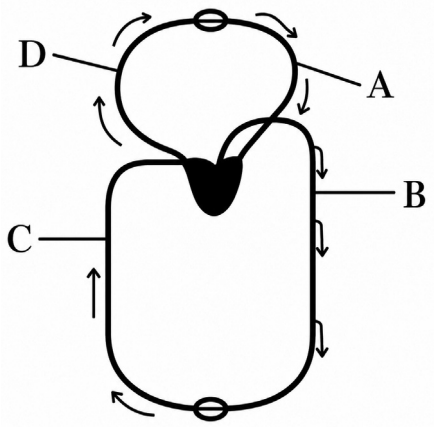
39. The diagram given here is the standard ECG of a normal person. The P-wave represents the



(1) beginning of the systole
(2) end of systole
(3) contraction of both the atria
(4) initiation of the ventricular contraction.

2013

40. The given figure shows schematic plan of blood circulation in humans with labels A to D. Identify the label and give its functions.



(1) C - Vena cava - Takes blood from body parts to right auricle, $pCO_2 = 45$ mm Hg
(2) D - Dorsal aorta - Takes blood from heart to body parts, $pO_2 = 95$ mm Hg
(3) A - Pulmonary vein - Takes impure blood from body parts, $pO_2 = 60$ mm Hg
(4) B - Pulmonary artery - Takes blood from heart to lungs, $pO_2 = 90$ mm Hg

ANSWERS

1. (2) Fibrinogen is produced from fibrin
During blood clotting, soluble fibrinogen is converted into insoluble fibrin by the enzyme thrombin, not the reverse. Therefore the statement that fibrinogen is produced from fibrin is incorrect. Fibrin threads form a meshwork that traps blood cells, producing the clot.

2. (4) 70-75
The sino-atrial node (SAN) is the pacemaker of the heart and generates about 70-75 action potentials per minute, setting the normal heart rate. Each impulse triggers one heartbeat, so the SAN produces around 72 beats per minute at rest.

3. (4) tricuspid valve
The opening between the right atrium and right ventricle is guarded by the tricuspid valve, which has three flaps and prevents backflow of blood into the atrium. The bicuspid (mitral) valve guards the left atrioventricular opening.

4. (2) 160-240/cu.mm and 1600-2000/cu.mm, respectively
Eosinophils make up about 2-3% of WBCs, giving roughly 160-240/cu.mm of 8000. Lymphocytes form about 20-25% of WBCs, giving about 1600-2000/cu.mm. These percentages applied to a total count of 8000 yield option (2) as the correct approximate values.

5. (4) D and E only
Rh incompatibility occurs when the mother is Rh-ve and the foetus is Rh+ve, opposite to statement D, so D is incorrect. Anti-Rh antibodies must be given after the first delivery, not the second, to protect later pregnancies, so E is incorrect. A, B and C are correct.

6. (4) C and D only
Blood compatibility depends on the antigens and antibodies present in the donor and recipient. A person with blood group A Rh^- has A antigens on the RBCs and anti-B antibodies in the plasma. Since they lack the Rh antigen, they can only receive Rh^-negative blood. Consequently, they can safely accept blood from donors with O Rh^- and A Rh^- types.

7. (4) closure of the tricuspid and bicuspid valves
The cardiac cycle produces two distinct heart sounds. The first sound, known as lub, is low-pitched and of longer duration. It is specifically caused by the simultaneous closure of the tricuspid and bicuspid valves at the beginning of ventricular systole. This closure prevents the backward flow of blood into the atria as the ventricles start to contract to pump blood.

8. (1) E-C-A-D-B
The heart's electrical conduction system coordinates the heartbeat through a specific sequence. It begins at the sinoatrial node, then travels to the atrioventricular node. From there, the impulse moves through the atrioventricular bundle and splits into bundle branches. Finally, it reaches the Purkinje fibres, ensuring that the ventricles contract efficiently to pump blood throughout the body to maintain systemic circulation.

9. (2) A-III, B-II, C-IV, D-I
An electrocardiogram records the electrical activity of the heart. The P wave represents atrial depolarisation, leading to contraction. The QRS complex indicates ventricular depolarisation, initiating ventricular systole. The T wave signifies ventricular repolarisation. The T-P interval represents the period when the heart muscles are electrically silent and the entire heart is in a state of complete joint diastole during the cycle.

10. (3) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
Different types of white blood cells exist in specific proportions within human blood. Neutrophils are the most abundant, making up sixty to sixty-five percent. Lymphocytes follow at twenty to twenty-five percent. Monocytes comprise six to eight percent of the total, while eosinophils are present at two to three percent. These percentages are crucial for diagnosing various medical conditions and infections in patients.

11. (1) B and C only
Basophils are a type of granulocyte involved in the body's immune and inflammatory responses. They secrete important chemical mediators like

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(3) break up into capillaries which reunite to form a vein
(4) carry blood from one visceral organ to another visceral organ.

2011

50. Which one of the following statements is correct regarding blood pressure?
(1) 130/90 mm Hg is considered high and requires treatment.
(2) 100/55 mm Hg is considered an ideal blood pressure.
(3) 105/50 mm Hg makes one very active.
(4) 190/110 mm Hg may harm vital organs like brain and kidney.

2010

51. Which two of the following changes (i - iv) usually tend to occur in the plain dwellers when they move to high altitudes (3,500 m or more)?
(i) Increase in red blood cell size
(ii) Increase in red blood cell production
(iii) Increased breathing rate
(iv) Increase in thrombocyte count
Changes occurring are
(1) (ii) and (iii)
(2) (iii) and (iv)
(3) (i) and (iv)
(4) (i) and (ii).

Mains 2010

52. The haemoglobin content per 100 mL of blood of a normal healthy human adult is
(1) 5 - 11 mg (2) 25 - 30 mg
(3) 17 - 20 mg (4) 12 - 16 mg.

Mains 2010

53. Fastest distribution of some injectible material/ medicine and with no risk of any kind can be achieved by injecting it into the
(1) muscles
(2) arteries
(3) veins
(4) lymph vessels.

Mains 2010

54. Given below are four statements (i-iv) regarding human blood circulatory system.
(i) Arteries are thick-walled and have narrow lumen as compared to veins.
(ii) Angina is acute chest pain when the blood circulation to the brain is reduced.
(iii) Persons with blood group AB can donate blood to any person with any blood group under ABO system.
(iv) Calcium ions play a very important role in blood clotting.
Which two of the above statements are correct?
(1) (i) and (iv)
(2) (i) and (ii)
(3) (ii) and (iii)
(4) (iii) and (iv)

2009

55. There is no DNA in
(1) mature RBCs
(2) a mature spermatozoan
(3) hair root
(4) an enucleated ovum.

2009

56. Globulins contained in human blood plasma are primarily involved in
(1) osmotic balance of body fluids
(2) oxygen transport in the blood
(3) clotting of blood
(4) defence mechanisms of body.

2009

57. The most popularly known blood grouping is the ABO grouping. It is named ABO and not ABC, because "O" in it refers to having
(1) overdominance of this type on the genes for A and B types
(2) one antibody only - either anti - A or anti - B on the RBCs
(3) no antigens A and B on RBCs
(4) other antigens besides A and B on RBCs.

2009

58. Compared to blood our lymph has
(1) plasma without proteins
(2) more WBCs and no RBCs
(3) more RBCs and less WBCs
(4) no plasma.

2009

59. In a standard ECG which one of the following alphabets is the correct representation of the respective activity of the human heart?
(1) S - start of systole
(2) T - end of diastole
(3) P - depolarisation of the atria
(4) R - repolarisation of ventricles

2008

60. The most active phagocytic white blood cells are
(1) eosinophils and lymphocytes
(2) neutrophils and monocytes
(3) neutrophils and eosinophils
(4) lymphocytes and macrophages.

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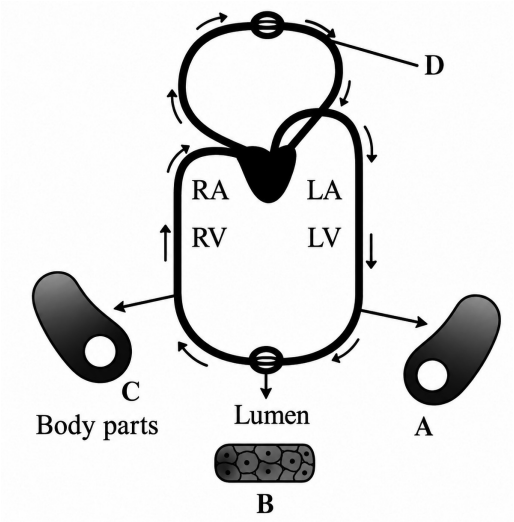
Karnataka NEET 2013

41. The figure shows blood circulation in humans with labels A to D. Select the option which gives correct identification of label and functions of the part.



(1) B - Capillary-Thin without muscle layer and wall two cell layers thick
(2) C - Vein-Thin walled and blood flows in jerks/ spurts
(3) D - Pulmonary vein-Takes oxygenated blood to heart, $pO_2 = 95$ mmHg
(4) A - Artery-Thick walled and blood flows evenly

2012

42. A certain road accident patient with unknown blood group needs immediate blood transfusion. His one doctor friend at once offers his blood. What was the blood group of the donor?
(1) Blood group B
(2) Blood group AB
(3) Blood group O
(4) Blood group A

Mains 2012

43. Which one of the following human organs is often called the "graveyard" of RBCs?
(1) Gall bladder (2) Kidney
(3) Spleen (4) Liver

2011

44. Which one of the following plasma proteins is involved in the coagulation of blood?
(1) Albumin
(2) Serum amylase
(3) Globulin
(4) Fibrinogen

2011

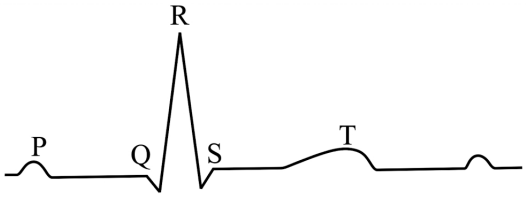
45. A person with unknown blood group under ABO system, has suffered much blood loss in an accident and needs immediate blood transfusion. His friend who has valid certificate of his own blood type, offers for blood donation without delay. What would have been the type of blood group of the donor friend?
(1) Type B (2) Type AB
(3) Type O (4) Type A

2011

46. 'Bundle of His' is a part of which one of the following organs in humans?
(1) Brain (2) Heart
(3) Kidney (4) Pancreas

Mains 2011

47. Given below is the ECG of a normal human. Which one of its components is correctly interpreted below?



(1) Complex QRS - one complete pulse
(2) Peak T - initiation of total cardiac contraction
(3) Peak P and peak R together - systolic and diastolic blood pressures
(4) Peak P- initiation of left atrial contraction only

2011

48. If due to some injury the chordae tendinae of the tricuspid valve of the human heart is partially non-functional, what will be the immediate effect?
(1) The flow of blood into the aorta will be slowed down.
(2) The 'pacemaker' will stop working.
(3) The blood will tend to flow back into the left atrium.
(4) The flow of blood into the pulmonary artery will be reduced.

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2011

49. Arteries are best defined as the vessels which
(1) supply oxygenated blood to the different organs
(2) carry blood away from the heart to different organs

2000

74. Which statement is true for WBC?
(1) Non-nucleated
(2) In deficiency, cancer is caused
(3) Manufactured in thymus
(4) Can squeeze through blood capillaries

2000

75. Difference between pulmonary artery and pulmonary vein is that, the pulmonary artery has
(1) no endothelium
(2) valves
(3) thicker walls
(4) oxygenated blood.

2000

76. In which point, pulmonary artery is different from pulmonary vein?
(1) Its lumen is broad.
(2) Its wall is thick.
(3) It has valves.
(4) It does not possess endothelium.

1999

77. Which is the principal cation in the plasma of the blood?
(1) Potassium
(2) Magnesium
(3) Calcium
(4) Sodium

1999

78. The blood group, with antibody-A and antibody-B is
(1) O
(2) B
(3) A
(4) AB.

1999

79. The problem, due to Rh^- factor arises when the blood of two (RH^+ and Rh^-) mix up
(1) during pregnancy
(2) in a test tube
(3) through transfusion
(4) both (a) and (c).

1999

80. Rate of heart beat is determined by
(1) Purkinje fibres
(2) papillary muscles
(3) AV node
(4) SA node.

1999

81. The thickening of walls of arteries is called
(1) arteriosclerosis
(2) arthritis
(3) aneurysm
(4) both (b) and (c)

1998

82. Which of the following is not the main function of lymph glands?
(1) Forming RBCs
(2) Destroying bacteria
(3) Forming WBCs
(4) Forming antibodies

1998

83. An adult human with average health has systolic and diastolic pressures as
(1) 120 mm Hg and 80 mm Hg
(2) 50 mm Hg and 80 mm Hg
(3) 80 mm Hg and 80 mm Hg
(4) 70 mm Hg and 120 mm Hg.

1997

84. Which of the following is agranulocyte?
(1) Basophil (2) Neutrophil
(3) Lymphocyte (4) Eosinophil

1997

85. The life span of human WBC is approximately
(1) between 2 to 3 months
(2) more than 4 months
(3) less than 10 days
(4) between 20 to 30 days.

1996

86. Which vertebrate organ receives only oxygenated blood?
(1) Spleen (2) Liver
(3) Gill (4) Lung

1995

87. The lymph serves to
(1) return the interstitial fluid to the blood
(2) return the WBCs and RBCs to the lymph nodes
(3) transport CO_2 to the lungs
(4) transport O_2 to the brain.

1995

88. The correct route through which pulse-making impulse travels in the heart is
(1) SA node → Purkinje fibres → bundle of His → AV node → heart muscles
(2) SA node → AV node → bundle of His → Purkinje fibres → heart muscles

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the ventricles enter the systolic phase to pump blood into the major systemic and pulmonary arteries.

21. (2) (iv) (i) (ii) (iii)
Each wave in an electrocardiogram corresponds to a specific cardiac event. The P wave indicates atrial depolarisation, while the QRS complex represents ventricular depolarisation. The T wave signifies the repolarisation of the ventricles. A reduction in the size of the T wave can be a clinical indicator of coronary ischaemia, which occurs when the heart muscle receives insufficient oxygen for metabolism.

22. (4) 100 beats per minute
Heart rate can be determined using the cardiac output and stroke volume. The stroke volume is the difference between the end-diastolic volume and the end-systolic volume, which is fifty millilitres in this case. By dividing the total cardiac output of five thousand millilitres by the stroke volume of fifty millilitres, we calculate a heart rate of exactly one hundred beats per minute.

23. (4) (ii) (iii) (i)
Plasma contains several major proteins that perform essential physiological functions. Fibrinogen is critical for blood clotting and prevents excessive blood loss during injury. Globulins are primarily involved in the body's defense mechanisms by acting as antibodies. Albumin is responsible for maintaining the osmotic balance of the blood, ensuring that water is retained within the circulatory system for proper pressure and volume.

24. (1) (iii) (i) (ii)
The heart contains valves that ensure blood flows in only one direction. The tricuspid valve is situated between the right atrium and the right ventricle. The bicuspid or mitral valve is located between the left atrium and the left ventricle. Semilunar valves are found at the openings of the right ventricle into the pulmonary artery and the left ventricle into the aorta.

25. (4) Only (D)
Mature human red blood cells are enucleate, meaning they lack a nucleus. This structural adaptation is highly efficient as it provides more internal space for carrying haemoglobin. By maximizing the volume available for this iron-containing protein, the erythrocytes can transport the largest possible amount of oxygen to the body's tissues, meeting the high metabolic demands of the adult human organs.

26. (3) intestine
The hepatic portal system is a unique vascular connection in the body. The hepatic portal vein carries blood from the intestine and other digestive organs directly to the liver before it returns to the systemic circulation. This arrangement allows the liver to process, detoxify, and store nutrients absorbed from food, ensuring that the blood composition is regulated effectively before entering general circulation.

27. (4) Thrombocytes
Thrombocytes, commonly known as platelets, are cell fragments produced from megakaryocytes in the bone marrow. They play a fundamental role in blood coagulation. A significant reduction in the number of thrombocytes can lead to clotting disorders. This condition results in excessive blood loss from the body even after minor injuries, as the blood fails to form a stable and effective clot.

NODIA

28. (3) lacking clotting factors
Serum is the fluid component of blood that remains after the blood has clotted. While it contains electrolytes, hormones, and various proteins like albumins and globulins, it specifically lacks clotting factors such as fibrinogen. Because these factors are consumed during the formation of the clot, serum cannot coagulate further, making it useful for many diagnostic laboratory tests and therapeutic medicinal applications.

29. (1) more than that in the pulmonary vein
In the circulatory system, blood pressure is higher in arteries than in veins. The pulmonary artery carries deoxygenated blood from the right ventricle to the lungs under significant pressure generated by ventricular contraction. In contrast, the pulmonary vein returns oxygenated blood to the left atrium at a much lower pressure. Therefore, the pressure in the pulmonary artery is greater than the vein.

30. (1) Hepatic vein
The liver is the primary organ responsible for the synthesis of urea through the ornithine cycle. Once urea is produced, it is released directly into the hepatic vein, which carries the blood away

1989

103. Which one engulfs pathogens rapidly?
(1) Acidophils
(2) Monocytes
(3) Basophils
(4) Neutrophils

1989

104. Lymph differs from blood in possessing
(1) only WBC
(2) more RBC and WBC
(3) more RBC and few WBC
(4) more WBC and few RBC.

1989

105. Tricuspid valve is found in between
(1) sinus venosus and right auricle
(2) right auricle and right ventricle
(3) left ventricle and left auricle
(4) ventricle and aorta.

1989

106. Arteries carry oxygenated blood except
(1) pulmonary
(2) cardiac
(3) hepatic
(4) systemic.

1988

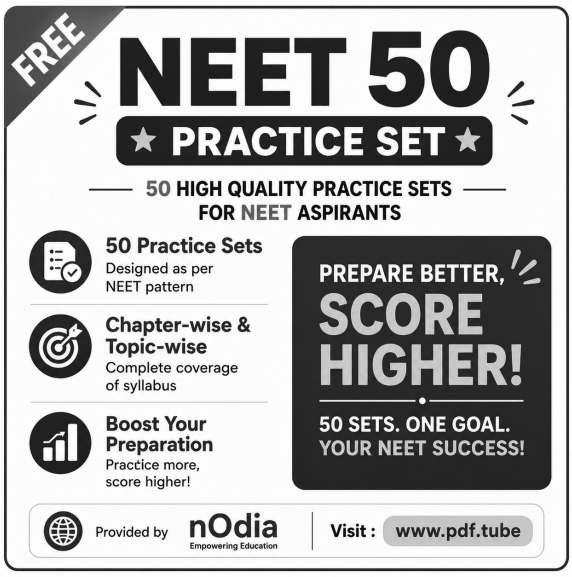
107. Child death may occur in the marriage of
(1) RH^+ man and RH^+ woman
(2) RH^+ man and Rh^- woman
(3) Rh^- man and Rh^- woman
(4) Rh^- man and RH^+ woman.

1988

108. Breakdown product of haemoglobin is
(1) bilirubin
(2) iron
(3) biliverdin
(4) calcium.

1988

109. RBCs do not occur in
(1) frog
(2) cow
(3) camel
(4) cockroach.



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2008

61. Which type of white blood cells are concerned with the release of histamine and the natural anticoagulant heparin?
(1) Eosinophils
(2) Monocytes
(3) Neutrophils
(4) Basophils

2008

62. In humans, blood passes from the post caval to the diastolic right atrium of heart due to
(1) stimulation of the sino auricular node
(2) pressure difference between the post caval and atrium
(3) pushing open of the venous valves
(4) suction pull.

2007

63. A drop of each of the following, is placed separately on four slides. Which of them will not coagulate?
(1) Blood serum
(2) Sample from the thoracic duct of lymphatic system
(3) Whole blood from pulmonary vein
(4) Blood plasma

2006

64. Which one of the following has an open circulatory system?
(1) Octopus
(2) Pheretima
(3) Periplaneta
(4) Hirudinaria

2004

65. You are required to draw blood from a patient and to keep it in a test tube for analysis of blood corpuscles and plasma. You are also provided with the following four types of test tubes. Which of these you will not use for the purpose?
(1) Test tube containing calcium bicarbonate
(2) Chilled test tube
(3) Test tube containing heparin
(4) Test tube containing sodium oxalate

2003

66. In the ABO system of blood groups, if both antigens are present but no antibody, the blood group of the individual would be
(1) B
(2) O
(3) AB
(4) A.

2003

67. The cardiac pacemaker in a patient fails to function normally. The doctors find that an artificial pacemaker is to be grafted in him. It is likely that it will be grafted at the site of
(1) atrioventricular bundle
(2) Purkinje system
(3) sinoatrial node
(4) atrioventricular node.

NODIA

2003

68. Bundle of His is a network of
(1) muscle fibres distributed throughout the heart walls
(2) muscle fibres found only in the ventricle wall
(3) nerve fibres distributed in ventricles
(4) nerve fibres found throughout the heart.

2003

69. Systemic heart refers to
(1) the heart that contracts under stimulation from nervous system
(2) left auricle and left ventricle in higher vertebrates
(3) entire heart in lower vertebrates
(4) the two ventricles together in humans.

2002

70. Which of the following statements is true for lymph?
(1) WBC + serum
(2) Blood – RBCs and some proteins
(3) RBCs + WBCs + plasma
(4) RBCs + proteins + platelets

2002

71. Impulse of heart beat originates from
(1) SA node (2) AV node
(3) vagus nerve (4) cardiac nerve.

2001

72. What is correct for blood group O?
(1) No antigens but both a and b antibodies are present.
(2) A antigen and b antibody present.
(3) Antigen and antibody both absent.
(4) A and B antigens and a, b antibodies present.

2000

73. Erythroblastosis fetalis is caused when fertilisation takes place between gametes of
(1) Rh^- female and RH^+ male
(2) RH^+ female and Rh^- male
(3) RH^+ female and RH^+ male
(4) Rh^- female and Rh^- male.

histamine, serotonin, and heparin. Although they are the least abundant white blood cells, their role is vital. They typically possess a trilobed nucleus and are easily identified by their granular appearance when stained with basic dyes during detailed microscopic laboratory analysis.

12. (4) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
A standard electrocardiogram captures specific electrical events throughout the cardiac cycle. The P wave corresponds to the depolarisation of the atria. The QRS complex represents the depolarisation of the ventricles, which triggers their contraction. The T wave indicates the repolarisation of the ventricles. Finally, the end of the T wave marks the completion of ventricular systole and the beginning of diastole.

13. (3) A-III, B-I, C-IV, D-II
Electrocardiograms utilize specific waves to represent cardiac activities. The P wave signifies the electrical excitation or depolarisation of the atria. The Q wave marks the beginning of ventricular systole. The QRS complex corresponds to ventricular depolarisation, which leads to contraction. The T wave represents the return of the ventricles from an excited to a normal state during the process of repolarisation.

14. (3) A, B and C only
Heart activities are controlled through intrinsic and extrinsic mechanisms. The nodal tissue provides auto-regulation for the rhythmic contraction of heart muscles. Extrinsically, a specialized neural centre in the medulla oblongata regulates cardiac function via the autonomic nervous system. Additionally, adrenal medullary hormones, such as adrenaline and noradrenaline, can increase cardiac output and heart rate during stressful or emergency survival situations.

15. (4) Statement I is incorrect but statement II is correct.
Blood clotting involves the formation of a coagulum, which consists of a network of threads called fibrins that trap dead and damaged formed elements. Thrombin is actually the enzyme that converts fibrinogen into these fibrin threads. Regarding red blood cells, the spleen functions as their graveyard because it filters out and destroys old or damaged erythrocytes after their normal lifespan.

16. (3) Blood moves freely from atrium to the ventricle during joint diastole.
During the phase of joint diastole, all four chambers of the heart are in a relaxed state. In this condition, the tricuspid and bicuspid valves remain open, allowing blood to flow freely from the pulmonary veins and vena cava into the ventricles through the atria. This passive filling accounts for a significant portion of the total ventricular blood volume during every cycle.

17. (1) absence of antibodies, anti-A and anti-B, in plasma
Individuals with the AB blood group are known as universal recipients. This classification is based on the fact that their red blood cells carry both A and B antigens on their surface. Crucially, their plasma lacks both anti-A and anti-B antibodies. Consequently, they can safely receive blood from any ABO group without experiencing an adverse immune reaction or dangerous cell agglutination.

18. (2) Thrombin
The process of blood coagulation requires a series of enzymatic reactions known as the cascade process. Thrombin is the key enzyme responsible for converting the inactive plasma protein fibrinogen into insoluble fibrin threads. These threads form a meshwork that traps blood cells to create a clot. Thrombin itself is formed from prothrombin by the action of the specific enzyme complex called thrombokinase.

19. (1) (iii) (iv) (ii) (i)
White blood cells serve diverse functions in the human immune system. Eosinophils release histaminase and are associated with allergic reactions. Basophils secrete granules containing histamine to mediate inflammation. Neutrophils are primarily phagocytic cells that destroy foreign organisms. Lymphocytes are responsible for specific immune responses, with B and T types producing antibodies and coordinating cell-mediated immunity to protect the entire body.

20. (3) depolarisation of ventricles
The QRS complex is a prominent feature in a standard electrocardiogram. It represents the depolarisation of the ventricles, which marks the start of ventricular contraction. This electrical activity is much stronger than atrial depolarisation because the ventricles have a larger muscle mass. Following the QRS complex,

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(3) AV node → bundle of His → SA node → Purkinje fibres → heart muscles
(4) AV node → SA node → Purkinje fibres → bundle of His → heart muscles.

1995

89. The neurogenic heart is the characteristic feature of
(1) humans (2) arthropods
(3) rabbits (4) rats.

1995

90. In veins, valves are present to check backward flow of blood flowing at
(1) atmospheric pressure
(2) high pressure
(3) low pressure
(4) all of these.

1994

91. The heart sound 'dup' is produced when
(1) mitral valve is closed
(2) semi-lunar valves at the base of aorta get closed
(3) tricuspid valve is opened
(4) mitral valve is opened.

1994

92. The pacesetter in the heart is called
(1) sino-atrial node (SAN)
(2) atrio-ventricular node (AVN)
(3) Purkinje fibres
(4) papillary muscle.

1993

93. Vitamin K is required for
(1) change of prothrombin into thrombin
(2) synthesis of prothrombin
(3) change of fibrinogen to fibrin
(4) formation of thromboplastin.

1993

94. Blood capillaries are made of
(1) endothelium, connective tissue and muscle fibres
(2) endothelium and muscle fibres
(3) endothelium and connective tissue
(4) endothelium only.

1992

95. Cells formed in bone marrow include
(1) RBCs
(2) RBCs and leucocytes
(3) leucocytes
(4) lymphocytes.

1992

96. Component of blood responsible for producing antibodies is
(1) thrombocytes
(2) monocytes
(3) erythrocytes
(4) lymphocytes.

1991

97. Blood group AB has
(1) no antigen
(2) no antibody
(3) neither antigen nor antibody
(4) both antigen and antibody.

1991

98. Wall of blood capillary is formed of
(1) haemocytes
(2) parietal cells
(3) endothelial cells
(4) oxyntic cells.

1991

99. Splenic artery arises from
(1) anterior mesenteric artery
(2) coeliac artery
(3) posterior mesenteric artery
(4) intestinal artery.

1990

100. A vein possesses a large lumen because
(1) tunica media and tunica externa form a single coat
(2) tunica interna and tunica media form a single coat
(3) tunica interna, tunica media and tunica externa are thin
(4) tunica media is a thin coat.

1989

101. Removal of calcium from freshly collected blood would
(1) cause delayed clotting
(2) prevent clotting
(3) cause immediate clotting
(4) prevent destruction of haemoglobin

1989

102. A person with blood group A requires blood. The blood group which can be given is
(1) A and B
(2) A and AB
(3) A and O
(4) A, B, AB and O.

NODIA

from the liver toward the heart. Consequently, the hepatic vein normally contains the highest concentration of urea in the body compared to other blood vessels like the renal vein.

31. (2) red bone marrow
Erythropoiesis is the physiological process by which red blood cells are produced. In human adults, this process primarily occurs within the red bone marrow of long bones and flat bones. The marrow contains hematopoietic stem cells that differentiate into mature erythrocytes. While other organs like the liver and spleen handle this function during embryonic development, red bone marrow is the main site post-birth.

32. (2) Blood = Plasma + RBC + WBC + Platelets
Blood is a complex fluid connective tissue composed of several distinct components. It consists of a liquid matrix called plasma, in which various formed elements are suspended. These formed elements include erythrocytes or red blood cells, leucocytes or white blood cells, and thrombocytes or platelets. Together, these components work to transport gases, nutrients, and hormones while providing essential immune and clotting functions.

33. (4) Semilunar valves close down after the blood flows into vessels from ventricles.
During the cardiac cycle, doctors listen for two main sounds using a stethoscope. The second heart sound, known as dup, is a sharp, high-pitched sound. It occurs at the beginning of ventricular diastole when the semilunar valves in the aorta and pulmonary artery close. This closure prevents the backflow of blood from the major vessels into the relaxing ventricles of the heart.

34. (1) systole of the left ventricle
Blood pressure in the mammalian aorta reaches its peak during the phase of ventricular systole, specifically when the left ventricle contracts. This contraction forces a large volume of oxygenated blood into the aorta under high pressure. This maximum pressure is referred to as systolic blood pressure. Conversely, the pressure drops during diastole when the heart muscle relaxes and the chambers refill.

35. (1) Whale
Double circulation involves two separate pathways: pulmonary circulation for gas exchange and systemic circulation for the rest of the body. This system is characteristic of birds and mammals, including whales. In these animals, the four-chambered heart completely separates oxygenated and deoxygenated blood. This separation ensures an efficient supply of oxygen to tissues, supporting the high metabolic rates of homeothermic organisms.

36. (1) both A and B antigens on RBC but no antibodies in the plasma
A person with blood group AB is classified as a universal recipient because their erythrocytes express both A and B antigens. Significantly, their blood plasma contains no anti-A or anti-B antibodies. This absence of antibodies prevents the immune system from attacking incoming red blood cells from any other ABO group, allowing for safe transfusion from donors with type A, B, AB, or O blood.

37. (1) Reduce both heart rate and cardiac output.
The autonomic nervous system regulates heart function through sympathetic and parasympathetic signals. Parasympathetic neural signals, primarily delivered via the vagus nerve, act to decrease the rate of the heartbeat. By slowing down the conduction speed of action potentials, these signals also lead to a reduction in the overall cardiac output, helping the body conserve energy during resting or calm physiological states.

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38. (1) Basophil Secretes serotonin, inflammatory response
Basophils are a specific type of white blood cell characterized by a lobed nucleus and large granules in the cytoplasm. They represent a very small percentage of the total leucocyte count. These cells play a significant role in inflammatory responses by secreting important chemical substances such as serotonin, histamine, and heparin. Their presence is essential for mediating the body's reaction to allergens.

39. (3) contraction of both the atria
In a standard electrocardiogram, the P wave is the first small upward deflection. It represents the electrical excitation, or depolarisation, of the atria. This electrical event triggers the mechanical contraction of both the right and left atria. This contraction pushes blood into the ventricles, ensuring they are adequately

immunity is essential for long-term protection of the body against diseases.

97. (2) no antibody
The ABO blood grouping is defined by the presence of antigens on the red blood cells and antibodies in the plasma. Individuals with blood group AB have both A and B antigens on their erythrocytes. Because their immune system recognizes these antigens as "self," their plasma does not contain anti-A or anti-B antibodies. This lack of antibodies allows safe recipient status.

98. (3) endothelial cells.
Capillaries are microscopic vessels where the actual exchange of materials between the blood and tissues takes place. Their walls are uniquely adapted for this function, being composed entirely of a single layer of endothelial cells. This thin endothelial lining provides a minimal barrier, allowing oxygen, carbon dioxide, nutrients, and waste products to diffuse easily and rapidly between the bloodstream and body.

99. (2) coeliac artery
The coeliac artery, or coeliac trunk, is a major branch of the abdominal aorta that supplies oxygenated blood to the upper abdominal organs. It typically divides into three main branches: the left gastric artery, the common hepatic artery, and the splenic artery. The splenic artery is the largest of these branches and follows a tortuous path to deliver blood to the spleen.

100. (4) tunica media is a thin coat.
Blood vessels are composed of three layers: the tunica interna, tunica media, and tunica externa. In veins, the tunica media, which consists of smooth muscle and elastic fibers, is much thinner than in arteries. Because the walls are thinner and less muscular, the internal space, or lumen, of a vein is relatively larger. This allows veins to act as a blood reservoir.

101. (2) prevent clotting
Calcium ions are critical for the blood coagulation cascade. They act as cofactors in multiple steps, including the activation of factor X and the conversion of prothrombin to thrombin. If calcium is removed from a freshly collected blood sample, typically by adding chelating agents like EDTA or citrate, the clotting process is halted. Therefore, the removal of calcium effectively prevents coagulation.

102. (3) A and O
A person with blood group A has A antigens on their red blood cells and anti-B antibodies in their plasma. They can receive blood from donors who do not have the B antigen. This includes individuals with blood group A and those with blood group O, which has no surface antigens. Receiving blood from group B or AB would cause an adverse reaction.

103. (4) Neutrophils
Neutrophils are the most abundant white blood cells and serve as the body's primary defense against acute bacterial infections. They are highly mobile and are typically the first immune cells to reach an infection site. Using phagocytosis, neutrophils rapidly engulf and destroy invading pathogens. Their quick response and aggressive phagocytic activity are crucial for containing and eliminating infections in their early stages.

104. (1) only WBC
Lymph is a specialized fluid formed from the filtration of blood plasma into tissue spaces. It is very similar to blood plasma but lacks red blood cells and platelets. Its cellular content consists almost entirely of white blood cells, particularly lymphocytes. This absence of erythrocytes gives lymph its clear, colorless appearance and distinguishes it from blood, which contains both cell types.

105. (2) right auricle and right ventricle
The heart features several valves to maintain unidirectional blood flow. The tricuspid valve, named for its three flaps or cusps, is located between the right auricle and the right ventricle. Its primary function is to allow deoxygenated blood to flow from the atrium into the ventricle while preventing it from leaking back into the atrium when the right ventricle contracts.

106. (1) pulmonary
Arteries are generally defined as blood vessels that carry oxygen-rich blood away from the heart to the rest of the body. However, the pulmonary artery is a significant exception to this rule. It carries deoxygenated blood from the right ventricle of the heart to the lungs, where it can be replenished with oxygen. All other major arteries transport oxygenated blood.

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carry oxygenated blood, the pulmonary artery is an exception as it carries deoxygenated blood to the lungs. Arteries typically have thick, elastic walls to withstand the high pressure of blood being pumped directly from the ventricles of the heart.

50. (4) 190/110 mm Hg may harm vital organs like brain and kidney.
Normal blood pressure is typically around 120/80 millimetres of mercury. Hypertension occurs when readings are consistently elevated. Severe hypertension, such as a reading of 190/110 millimetres of mercury, is extremely dangerous. It places excessive stress on the vascular system and can lead to serious damage to vital organs, including the brain, heart, and kidneys, increasing the risk of cardiovascular events.

51. (1) (ii) and (iii)
When individuals move to high altitudes, the body compensates for lower atmospheric oxygen levels. The kidneys release erythropoietin, which stimulates the bone marrow to increase red blood cell production, enhancing the blood's oxygen-carrying capacity. Additionally, the breathing rate increases to intake more oxygen. These physiological adjustments help the body maintain adequate oxygenation despite the reduced environmental oxygen availability at high altitudes.

52. (4) 12 - 16 mg.
Haemoglobin is the iron-containing respiratory pigment found within red blood cells. In a normal, healthy human adult, the haemoglobin content typically ranges from twelve to sixteen grams per one hundred millilitres of blood. This concentration is essential for the efficient transport of oxygen from the lungs to the body's tissues and the return of carbon dioxide from the tissues back to the lungs.

53. (3) veins
Injecting medicine or fluids into the veins, known as intravenous injection, ensures the fastest distribution throughout the body. Once in the venous system, the material is carried directly to the heart and then pumped through the arterial system to all tissues. This method is highly effective for rapid therapeutic action and is generally safe when performed correctly by trained healthcare professionals.

54. (1) (i) and (iv)
Arteries are characterized by thick, muscular walls and a narrow lumen, which allows them to carry blood under high pressure away from the heart. In contrast, veins have thinner walls and a wider lumen. Regarding blood coagulation, calcium ions are essential cofactors in several steps of the clotting cascade. They facilitate the activation of various clotting factors that eventually lead to a clot.

55. (1) mature RBCs
Mature mammalian red blood cells undergo a process of enucleation during their development. As they mature, they lose their nucleus and other organelles like mitochondria and ribosomes. This loss is a specialized adaptation to provide more space for haemoglobin. Since the nucleus contains the cell's genetic material, mature red blood cells do not contain any DNA, unlike most other living cells.

56. (4) defence mechanisms of body.
Plasma proteins are grouped into three main categories: albumins, globulins, and fibrinogens. Globulins are primarily involved in the body's immune response and defense mechanisms. Specifically, gamma globulins act as antibodies that recognize and neutralize foreign pathogens such as bacteria and viruses. Their presence in the blood is vital for protecting the organism from various infections and maintaining overall health and immunity.

57. (3) no antigens A and B on RBCs
The ABO blood grouping system is based on the presence or absence of two surface antigens on red blood cells, namely A and B. Individuals with type A have the A antigen, while type B has the B antigen. Type AB has both. The designation "O" indicates the total absence of both A and B antigens on the erythrocyte surface, hence its name.

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58. (2) more WBCs and no RBCs
Lymph is a colorless fluid that circulates through the lymphatic system. It is derived from interstitial fluid and is similar in composition to blood plasma but with significant differences. Lymph contains a much higher concentration of white blood cells, particularly lymphocytes, which are crucial for immune function. Most importantly, lymph lacks red blood cells and

filled before the subsequent phase of ventricular contraction begins during the cardiac cycle.

40. (1) C - Vena cava - Takes blood from body parts to right auricle, $pCO_2 = 45$ mm Hg
The human circulatory system involves specific vessels for transporting blood with varying gas concentrations. The vena cava is a large vein that collects deoxygenated blood from the body's tissues and delivers it to the right atrium of the heart. This blood typically has a partial pressure of carbon dioxide around forty-five millimetres of mercury, reflecting the waste products gathered from cellular respiration.

41. (3) D - Pulmonary vein-Takes oxygenated blood to heart, $pO_2 = 95$ mmHg
The pulmonary vein is unique among veins as it carries oxygenated blood from the lungs to the left atrium of the heart. This blood is rich in oxygen, typically having a partial pressure of approximately ninety-five millimetres of mercury. This high oxygen content is essential for systemic circulation, where the blood is subsequently pumped by the left ventricle to supply the tissues.

42. (3) Blood group O
Blood group O is considered the universal donor type in the ABO blood group system. The red blood cells of individuals with group O blood lack both A and B antigens on their surface. This means their blood can be safely transfused into recipients of any blood group without causing a dangerous immune reaction or agglutination, making it vital in emergency medical situations.

43. (3) Spleen
The spleen is a secondary lymphoid organ located in the upper left part of the abdomen. It performs several critical functions, including filtering the blood. Red blood cells have a limited lifespan of about one hundred twenty days. Once they become old, worn out, or damaged, they are trapped and destroyed by macrophages in the spleen, which is why it is called the graveyard.

44. (4) Fibrinogen
Plasma proteins are essential for various bodily functions, including immunity and fluid balance. Fibrinogen is a large, soluble protein produced by the liver that plays a central role in the blood coagulation process. During an injury, it is converted into insoluble fibrin strands by the enzyme thrombin. These strands form a mesh that stabilizes the blood clot and prevents further bleeding.

45. (3) Type O
In an emergency where the recipient's blood group is unknown, type O blood is the safest option for immediate transfusion. This is because type O red blood cells do not have A or B antigens on their surface, preventing them from being attacked by the recipient's antibodies. Therefore, a person with type O blood can donate to individuals of any other group.

46. (2) Heart
The Bundle of His is a specialized collection of cardiac muscle fibers involved in the heart's electrical conduction system. It originates from the atrioventricular node and extends through the interventricular septum. Its primary function is to transmit electrical impulses from the atria to the ventricles. This ensures the coordinated contraction of the ventricles, which is necessary for the efficient pumping of blood.

47. (1) Complex QRS - one complete pulse
In a standard electrocardiogram, the QRS complex represents the electrical depolarisation of the ventricles. Because this event directly precedes and triggers ventricular contraction, the number of QRS complexes occurring in a given time period can be used to determine a person's heart rate. Thus, each complex effectively corresponds to one complete pulse or heartbeat, reflecting the mechanical activity of the heart.

48. (4) The flow of blood into the pulmonary artery will be reduced.
The chordae tendinae are strong strings that attach the tricuspid and bicuspid valves to the papillary muscles. They prevent the valves from collapsing into the atria during ventricular contraction. If the chordae tendinae of the tricuspid valve become non-functional, the valve may leak, allowing blood to flow back into the right atrium. This backflow significantly reduces the volume of blood pumped into the pulmonary artery.

49. (2) carry blood away from the heart to different organs
Arteries are blood vessels designed to transport blood away from the heart to various organs and tissues throughout the body. While most arteries

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transmits them down the interventricular septum toward the ventricles. These fibers then branch out into Purkinje fibers within the ventricle walls. This muscle-based network is essential for coordinating the synchronous contraction of chambers.

69. (2) left auricle and left ventricle in higher vertebrates
In higher vertebrates with a four-chambered heart, the heart is functionally divided into two parts. The right side handles pulmonary circulation, while the left side is responsible for systemic circulation. The left auricle and left ventricle together are often referred to as the systemic heart. They receive oxygenated blood from the lungs and pump it out to the rest of the body.

70. (2) Blood - RBCs and some proteins
Lymph is a fluid that forms when blood plasma filters out of capillaries into the surrounding tissues. It is essentially identical to blood plasma in its composition of water and small solutes but differs significantly because it lacks red blood cells and large plasma proteins. Lymph also contains a high number of lymphocytes, making it an integral part of the body's immune drainage system.

71. (1) SA node
The heartbeat is initiated by a specialized group of cardiac muscle cells called the sinoatrial node, located in the right atrium. Because it has the highest rate of spontaneous depolarisation, it sets the pace for the entire heart and is known as the primary pacemaker. The electrical impulse generated here travels through the atria and then to the rest of the conduction system.

72. (1) No antigens but both a and b antibodies are present.
Blood group O is characterized by the absence of both A and B antigens on the surface of the red blood cells. Because these antigens are missing, the immune system naturally produces both anti-A and anti-B antibodies in the plasma. This unique combination makes individuals with blood group O universal donors, although they can only receive blood from other group O donors.

73. (1) Rh^- female and RH^+ male
Erythroblastosis fetalis is a hemolytic disease that can occur during pregnancy. It typically arises when an Rh^-negative mother carries an Rh^-positive fetus, which usually happens if the father is Rh^-positive. During birth, the mother may be exposed to the fetus's Rh^-positive blood, leading to antibody production. In subsequent pregnancies with an Rh^-positive fetus, these antibodies can cross the placenta and attack the baby's RBCs.

74. (4) Can squeeze through blood capillaries
White blood cells, or leucocytes, are nucleated cells that play a central role in the body's immune defense. One of their most remarkable characteristics is diapedesis, the ability to change shape and squeeze through the narrow walls of blood capillaries. This allows them to move out of the circulatory system and into infected or damaged tissues where they fight various pathogens.

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75. (3) thicker walls
Like all arteries, the pulmonary artery has a structure designed to handle high-pressure blood flow. It possesses a thick, muscular wall with a well-developed tunica media. In contrast, the pulmonary vein has a thinner wall because it carries blood under much lower pressure back to the heart. This structural difference is a hallmark of the functional roles that arteries and veins play.

76. (2) Its wall is thick.
Arteries and veins differ structurally to accommodate the pressure of the blood they carry. The pulmonary artery has a significantly thicker, more muscular wall compared to the pulmonary vein. This thickness is necessary to withstand the high pressure generated when the right ventricle contracts to pump deoxygenated blood to the lungs. Veins, which carry blood at lower pressures, have thinner walls.

77. (4) Sodium
Blood plasma is the liquid component of blood and contains various electrolytes essential for physiological functions. Sodium is the principal and most abundant cation in the extracellular fluid, including plasma. It plays a vital role in maintaining osmotic pressure, regulating fluid balance, and facilitating the transmission of nerve

impulses and muscle contractions throughout the human body for normal metabolic functioning.

78. (1) O
In the ABO blood group system, the type of antibodies present in the plasma is opposite to the antigens found on the red blood cells. Individuals with blood group O have no A or B antigens on their erythrocytes. Consequently, their plasma contains both anti-A and anti-B antibodies. This makes blood group O recipients incompatible with blood from donors of groups A, B, and AB.

79. (4) both (a) and (c).
Rh factor incompatibility causes serious medical issues when Rh^+positive blood enters the system of an Rh^-negative individual. This most commonly occurs during pregnancy, where an Rh^-negative mother is carrying an Rh^+positive fetus, or during an incorrect blood transfusion. In both cases, the Rh^-negative person's immune system may produce antibodies against the Rh antigen, leading to potentially life-threatening hemolytic reactions in future exposures.

80. (4) SA node.
The heart's rhythmic contractions are controlled by its internal conduction system. The sinoatrial node, or SA node, is the primary determinant of the heart rate because it has the fastest rate of inherent depolarisation. It initiates electrical impulses that spread across the heart, setting the basic tempo for cardiac cycles. Although neural factors can modulate this rate, the SA node remains the pacemaker.

81. (1) arteriosclerosis
Arteriosclerosis is a general term describing the thickening, hardening, and loss of elasticity in the walls of the arteries. This condition can restrict blood flow to organs and tissues. A common subtype is atherosclerosis, which specifically involves the buildup of fatty plaques on the inner arterial walls. Both conditions can lead to serious cardiovascular problems, including heart attacks and strokes, if untreated.

82. (1) Forming RBCs
Lymph glands, or lymph nodes, are vital components of the lymphatic and immune systems. Their primary functions include filtering lymph to remove and destroy bacteria, producing certain types of white blood cells like lymphocytes, and generating antibodies to fight infections. However, they are not involved in the production of red blood cells, which occurs almost exclusively in the red bone marrow of adults.

83. (1) 120 mm Hg and 80 mm Hg
Blood pressure is recorded as two values representing the phases of the cardiac cycle. Systolic pressure is the higher number and measures the pressure in the arteries when the heart beats. Diastolic pressure is the lower number and measures the pressure when the heart rests between beats. For a healthy adult, a typical normal reading is approximately one hundred twenty over eighty millimetres of mercury.

84. (3) Lymphocyte
White blood cells are categorized into granulocytes and agranulocytes based on the presence of visible granules in their cytoplasm. Granulocytes include neutrophils, eosinophils, and basophils. Agranulocytes, which lack these granules, include lymphocytes and monocytes. Lymphocytes are crucial for the body's specific immune response, including the production of antibodies and the coordination of cell-mediated immunity against pathogens during infection or disease.

85. (3) less than 10 days
White blood cells generally have a much shorter lifespan than red blood cells. While some specific types of memory lymphocytes can live for years, the majority of leucocytes, especially granulocytes like neutrophils, circulate in the blood for only a few hours to a few days. Typically, their average lifespan is estimated to be less than ten days before they are replaced.

86. (1) Spleen
In the vertebrate body, most organs receive oxygenated blood through arteries and return deoxygenated blood through veins. However, the spleen is notable because it is supplied entirely by the splenic artery, which carries only oxygenated blood. While the liver receives both oxygenated and deoxygenated blood, the spleen's primary supply is purely oxygenated, supporting its high metabolic and immune filtration functions.

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87. (1) return the interstitial fluid to the blood
The lymphatic system plays a crucial role in maintaining fluid balance within the body. As blood circulates, some fluid filters out of the capillaries and into the spaces between cells, becoming interstitial fluid. The primary function of lymph is to collect this excess interstitial fluid, along with leaked proteins and fats, and return it to the venous blood circulation for homeostasis.

88. (2) SA node → AV node → bundle of His → Purkinje fibres → heart muscles
The electrical signal that triggers a heartbeat follows a precise anatomical pathway. It begins at the sinoatrial node and travels through the atria to the atrioventricular node. After a brief delay, the impulse moves into the bundle of His and then through the Purkinje fibres, which distribute the signal to the ventricular heart muscles. This sequence ensures heart chambers contract correctly.

89. (2) arthropods
A neurogenic heart is one where the heartbeat is initiated and controlled by nervous impulses from a ganglion located near the heart. This type of heart is characteristic of many invertebrates, particularly arthropods like crustaceans and some insects. In contrast, vertebrates have a myogenic heart, where the impulse for contraction originates within specialized cardiac muscle tissue, such as the sinoatrial node, instead of nerves.

90. (3) low pressure
Unlike arteries, veins carry blood back to the heart under relatively low pressure. To prevent the backward flow of blood, especially against the force of gravity in the lower limbs, veins are equipped with one-way valves. These valves ensure that blood moves steadily toward the heart. The combined action of these valves and the contraction of surrounding skeletal muscles helps maintain efficient return.

91. (2) semi-lunar valves at the base of aorta get closed
The second heart sound, phonetically described as 'dup', occurs during the beginning of ventricular diastole. It is produced by the sudden closure of the semilunar valves at the base of the aorta and the pulmonary artery. This closure happens when the pressure in the ventricles falls below the pressure in the major arteries, preventing blood from flowing back into the heart's chambers.

92. (2) atrio-ventricular node (AVN)
While the sinoatrial node is known as the primary pacemaker of the heart, the atrioventricular node is often referred to as the pacesetter. The AV node receives the electrical impulse from the SA node and delays it slightly before passing it to the ventricles. This delay allows the atria to finish contracting and empty their blood into the ventricles for efficient pumping.

93. (2) synthesis of prothrombin
Vitamin K is a fat-soluble vitamin that is essential for the blood clotting process. It acts as a vital cofactor for the liver's synthesis of several important coagulation proteins, most notably prothrombin. Without adequate levels of Vitamin K, the liver cannot produce these factors, leading to a significantly increased risk of bleeding and a failure of the blood to clot correctly.

NODIA

94. (4) endothelium only.
Blood capillaries are the smallest and thinnest blood vessels in the body, where the exchange of gases, nutrients, and waste products occurs. To facilitate this exchange, their walls are remarkably thin, consisting of only a single layer of squamous endothelial cells resting on a basement membrane. Capillaries lack the muscular and connective tissue layers found in larger vessels like arteries.

95. (2) RBCs and leucocytes
The red bone marrow is the primary site of hematopoiesis, the process of blood cell formation, in adult humans. It contains multipotent stem cells that give rise to all types of blood cells. This includes erythrocytes, all varieties of leucocytes, and thrombocytes. By continuously producing these cells, the bone marrow ensures a steady supply of new blood components for the body.

96. (4) lymphocytes.
Lymphocytes are a type of agranulocytic white blood cell that is central to the body's immune system. They are classified into two main types: B-lymphocytes and T-lymphocytes. B-lymphocytes are specifically responsible for producing antibodies, which are proteins that recognize and neutralize foreign antigens like bacteria and viruses. This antibody-mediated

CHAPTER 16

Excretory Products and Their Elimination

2026 (RE-NEET)

1. Which of the following statements about the reabsorption process in Henle's loop are correct ?

(a) Descending limb permeable to water but almost impermeable to electrolytes;

(b) Urine gets concentrated in Henle's loop;

(c) Reabsorption of Na^+ and water in Henle's loop;

(d) Active/passive transport of electrolytes in ascending limb.

(1) (a), (b) and (c) only

(2) (a), (b) and (d) only

(3) (a) and (b) only

(4) (b), (c) and (d) only

2026 (CANCELLED)

2. Arrange the following events occurring in Renin-Angiotensin mechanism in the correct order:

A. Increase in blood pressure and Glomerular filtration rate.

B. Reabsorption of Na^+ and water from distal parts of tubule due to Aldosterone.

C. Fall in Glomerular filtration rate.

D. Vasoconstriction by Angiotensin II and release of Aldosterone.

E. Renin converts Angiotensinogen into Angiotensin I, followed by Angiotensin II.

Choose the correct answer from the options given below :

(1) A, C, E, B, D

(2) C, A, B, D, E

(3) A, D, B, E, C

(4) C, E, D, B, A

2026 (CANCELLED)

3. The JGA (Juxta Glomerular Apparatus) is a special sensitive region formed by cellular modifications in _____ related to the same nephron.

(1) Distal convoluted tubule and efferent renal arteriole

(2) Proximal convoluted tubule and efferent renal arteriole.

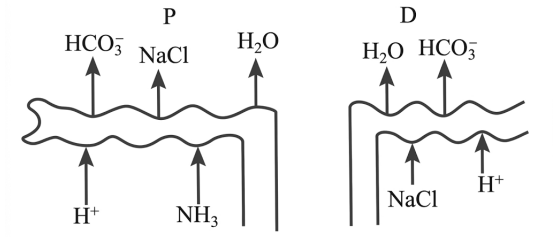
(3) Proximal convoluted tubule and afferent renal arteriole

(4) Distal convoluted tubule and afferent renal arteriole

2025

4. Which of the following diagrams is correct with regard to the proximal (P) and distal (D) tubule of the nephron?

(1)



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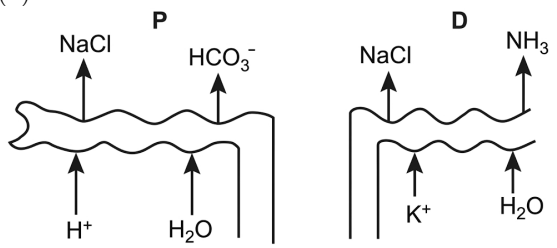

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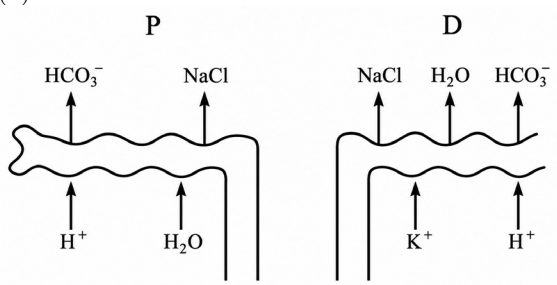

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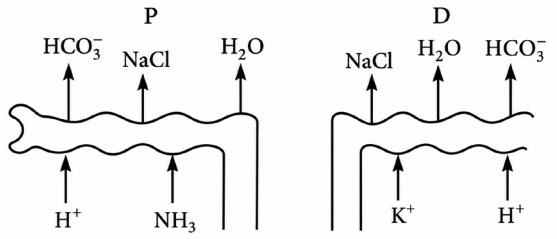

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107. (2) RH^+ man and Rh^- woman
Hemolytic disease of the newborn, or erythroblastosis fetalis, can be fatal for a child. This condition occurs when an Rh^-negative woman is married to an Rh^-positive man, leading to the conception of an Rh^-positive fetus. If the mother's immune system becomes sensitized to the Rh antigen during a first pregnancy, her antibodies may attack the red blood cells of a subsequent fetus.

108. (1) bilirubin
When red blood cells reach the end of their life cycle, they are broken down in the spleen and liver. Haemoglobin is released and processed into several components. The iron is recycled, while the remaining heme portion is converted into bile pigments. Bilirubin is the primary breakdown product, which is then excreted by the liver into the bile for normal digestive elimination.

109. (4) cockroach.
Red blood cells are a characteristic feature of vertebrate circulatory systems, where they transport oxygen using haemoglobin. In contrast, many invertebrates, like the cockroach, have an open circulatory system containing haemolymph. This fluid lacks red blood cells and often does not use respiratory pigments for oxygen transport. Instead, the cockroach relies on a complex tracheal system to deliver oxygen.

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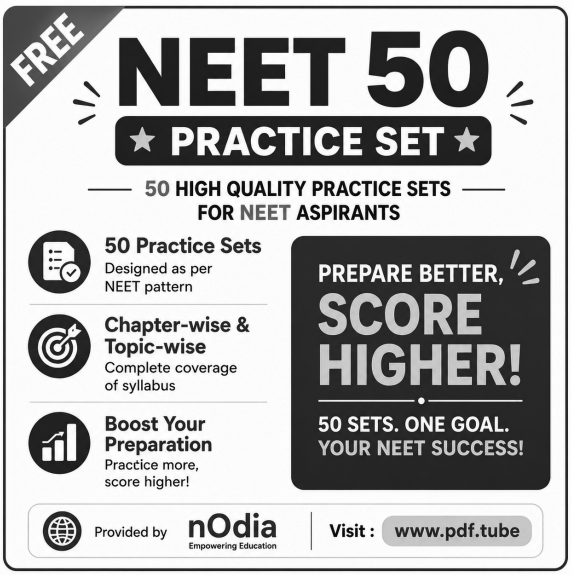

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large plasma proteins, distinguishing it clearly from whole blood.

59. (3) P - depolarisation of the atria
In a standard electrocardiogram, the different waves represent various electrical activities of the heart. The P wave specifically represents the depolarisation of the atria, which is the electrical signal that causes the atria to contract. This contraction assists in the final filling of the ventricles. Other waves, like the QRS complex and T wave, represent ventricular depolarisation and repolarisation, respectively, during the cycle.

60. (2) neutrophils and monocytes
Phagocytosis is a critical process where certain white blood cells engulf and destroy foreign particles, such as bacteria and cellular debris. Neutrophils and monocytes are the most active phagocytic cells in the human body. Neutrophils are the first to arrive at a site of infection, while monocytes migrate from the blood into tissues, where they differentiate into large macrophages to continue phagocytosis.

61. (4) Basophils
Basophils are a type of granulocyte that plays a key role in the body's allergic and inflammatory responses. They contain cytoplasmic granules that store and release several important chemical mediators. These include histamine, which increases blood vessel permeability during inflammation, and heparin, which acts as a natural anticoagulant to prevent blood from clotting too quickly. These secretions are vital for immune reactions.

62. (2) pressure difference between the post caval and atrium
Blood returns to the heart through the venous system, driven by several factors. In humans, blood moves from the post caval vein into the right atrium primarily due to the pressure difference between these two areas. During atrial diastole, the pressure in the right atrium drops below the pressure in the vena cava, allowing blood to flow passively into the heart chamber.

63. (1) Blood serum
Coagulation, or blood clotting, is a process that requires specific proteins known as clotting factors, including fibrinogen and prothrombin. Blood serum is defined as the liquid part of blood that remains after a clot has already formed. Because the clotting factors have been consumed during the initial clotting process, serum itself does not contain the necessary components to coagulate again when exposed.

NODIA

64. (3) Periplaneta
An open circulatory system is one in which blood, often called haemolymph, is not entirely contained within vessels. Instead, it is pumped into open spaces known as sinuses or a haemocoel, where it directly bathes the internal organs. This type of system is characteristic of many invertebrates, including arthropods like Periplaneta. In contrast, mollusks like octopuses and annelids have closed circulatory systems.

65. (1) Test tube containing calcium bicarbonate
To analyze blood corpuscles and plasma, it is essential to prevent the blood from clotting. Anticoagulants like heparin or sodium oxalate are commonly used for this purpose. Chilling the test tube can also slow down the enzymatic reactions of clotting. However, calcium ions are necessary for the blood clotting cascade. Therefore, a tube containing a calcium salt would actually promote coagulation.

66. (3) AB
The ABO blood grouping system is determined by the presence or absence of A and B antigens on the surface of red blood cells. If an individual's erythrocytes possess both A and B antigens, their immune system will not produce anti-A or anti-B antibodies. This specific combination of having both antigens and no corresponding plasma antibodies identifies the individual as having the AB blood group.

67. (3) sinoatrial node.
The sinoatrial node, or SAN, is known as the natural pacemaker of the heart because it generates the electrical impulses that initiate each heartbeat. If the sinoatrial node fails to function correctly, the heart's rhythm becomes irregular. In such cases, an artificial pacemaker is surgically implanted at the site of the sinoatrial node to take over the role of generating rhythmic electrical signals.

68. (2) muscle fibres found only in the ventricle wall
The Bundle of His is a specialized tract of cardiac muscle fibers that form part of the heart's conduction system. It receives electrical impulses from the atrioventricular node and

2024

5. Choose the correct statement given below regarding juxta medullary nephron.
(1) Juxta medullary nephrons are located in the columns of Bertini.
(2) Renal corpuscle of juxta medullary nephron lies in the outer portion of the renal medulla.
(3) Loop of Henle of juxta medullary nephron runs deep into medulla.
(4) Juxta medullary nephrons outnumber the cortical nephrons.

2024

6. Given below are two statements.
Statement I : In the nephron, the descending limb of loop of Henle is impermeable to water and permeable to electrolytes.
Statement II : The proximal convoluted tubule is lined by simple columnar brush border epithelium and increases the surface area for reabsorption.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are true.
(2) Both Statement I and Statement II are false.
(3) Statement I is true but Statement II is false.
(4) Statement I is false but statement II is true.

RE-EXAM 2024

7. Given below are two statements.
Statement I : Concentrated urine is formed due to counter current mechanism in nephron.
Statement II : Counter current mechanism helps to maintain osmotic gradient in the medullary interstitium.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

RE-EXAM 2024

8. Diuresis is prevented by
(1) renin from JG cells via switching off the osmoreceptors
(2) ANF from atria of the heart
(3) aldosterone from adrenal medulla
(4) vasopressin from neurohypophysis.

2023

9. Given below are statements. One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Nephrons are of two types: Cortical and Juxtamedullary, based on their relative position in cortex and medulla.
Reason (R) : Juxtamedullary nephrons have short loop of Henle whereas, cortical nephrons have longer loop of Henle.
In the light of the above statements, choose the correct answer from the options given below.
(1) (A) is true but (R) is false.
(2) (A) is false but (R) is true.
(3) Both (A) and (R) are true and (R) is the correct explanation of (A).
(4) Both (A) and (R) are true but (R) is not the correct explanation of (A).

Manipur NEET 2023

10. Given below are two statements.
One is labelled as Assertion (A) and the other is labelled as Reason (R)
Assertion (A) : Ascending limb of loop of Henle is impermeable to water and allows transport of electrolytes actively or passively.
Reason (R) : Dilution of filtrate takes place due to efflux of electrolytes in the medullary fluid.
In the light of the above statement, choose the correct answer from the options given below.
(1) (A) is true but (R) is false.
(2) (A) is false but (R) is true.
(3) Both (A) and (R) are true and (R) is the correct explanation of (A).
(4) Both (A) and (R) are true and (R) is not the correct explanation of (A).

Manipur NEET 2023

11. Arrange the events of Renin - Angiotensin mechanism in correct sequence.
A. Activation of JG cells and release of renin.
B. Angiotensin II activates release of aldosterone.
C. Fall in glomerular blood pressure.
D. Reabsorption of Na^+ and water from distal convoluted tubule.
E. Angiotensinogen is converted to Angiotensin I and then to Angiotensin II.
Choose the correct answer from the options given below.
(1) (C), (A), (E), (B), (D)
(2) (A), (D), (E), (C), (B)
(3) (A), (D), (C), (B), (E)
(4) (B), (A), (E), (D), (C)

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insects like cockroaches, excrete uric acid in a semi-solid form to conserve water in terrestrial environments.

29. (4) Ureotelic mode of excretion
Both humans and adult frogs share the characteristic of being ureotelic. This means they convert highly toxic ammonia, produced during protein metabolism, into urea in the liver. Urea is less toxic and can be safely transported and excreted by the kidneys. While frogs have three-chambered hearts and nucleated red blood cells, humans possess four-chambered hearts and non-nucleated red blood cells.

30. (3) Proximal convoluted tubule
The proximal convoluted tubule is the most active segment of the nephron regarding reabsorption. It is lined with simple cuboidal brush border epithelium, which provides an extensive surface area. Under normal physiological conditions, approximately seventy to eighty percent of the electrolytes and water from the glomerular filtrate are reabsorbed here. It also ensures the total reabsorption of glucose and amino acids.

31. (1) juxtaglomerular cells to release renin
A reduction in glomerular filtration rate, blood volume, or blood pressure is detected by the juxtaglomerular apparatus. This triggers the specialized juxtaglomerular cells to release the enzyme renin into the bloodstream. Renin then initiates the renin-angiotensin-aldosterone system, which ultimately works to increase blood pressure and restore the filtration rate to normal levels through vasoconstriction and increased salt reabsorption.

32. (1) reptiles and birds
Uricotelism is an adaptation for water conservation in terrestrial animals. These organisms convert nitrogenous wastes into uric acid, which is relatively non-toxic and insoluble in water. This allows for excretion as a semi-solid paste with minimal water loss. Common examples of uricotelic animals include most reptiles, birds, land snails, and insects. Annelids and amphibians generally use different modes of excretion.

33. (2) Convoluted tubules
The kidney is divided into an outer cortex and an inner medulla. The medulla is organized into several conical masses known as renal pyramids. These pyramids primarily contain the straight segments of the nephrons, such as the loops of Henle and the collecting ducts, along with peritubular capillaries. The proximal and distal convoluted tubules are located exclusively in the renal cortex.

34. (1) Podocytes : create minute spaces (slit pores) for the filtration of blood into the Bowman's capsule
Podocytes are specialized epithelial cells that line the inner wall of the Bowman's capsule. They possess foot-like processes that interlock, leaving small gaps called filtration slits or slit pores. These pores allow for the ultrafiltration of blood plasma from the glomerulus into the capsular space. Most reabsorption actually occurs in the proximal tubule, rather than the loop of Henle.

35. (1) When someone drinks lot of water, ADH release is suppressed.
Osmoreceptors in the body monitor the osmolarity of blood. Consuming a large volume of water decreases blood osmolarity, which inhibits the release of antidiuretic hormone from the neurohypophysis. Without ADH, the distal tubules become less permeable to water, leading to the excretion of large amounts of dilute urine. This regulatory mechanism helps the body maintain a constant internal fluid balance.

36. (4) in the liver, but eliminated mostly through kidneys.
Urea is the primary nitrogenous excretory product in humans. It is synthesized in the liver through a series of biochemical reactions known as the urea cycle or ornithine cycle. This process converts toxic ammonia into less harmful urea. Once produced, urea is released into the bloodstream and transported to the kidneys, where it is filtered and subsequently excreted in urine.

37. (3) Nearly 99 per cent of the glomerular filtrate is reabsorbed by the renal tubules.
The kidneys filter a massive volume of fluid daily, approximately 180 liters. However, the average daily urine output is only about 1.5 liters. This indicates that nearly 99 percent of the glomerular filtrate is reabsorbed as it passes through the renal tubules. Other statements regarding the permeability of the loop of Henle and the reabsorption of bicarbonate are physiologically incorrect.

NODIA

2017

19. Which of the following statements is correct?
(1) The descending limb of loop of Henle is impermeable to water.
(2) The ascending limb of loop of Henle is permeable to water.
(3) The descending limb of loop of Henle is permeable to electrolytes.
(4) The ascending limb of loop of Henle is impermeable to water.

2017

20. A decrease in blood pressure/volume will not cause the release of
(1) atrial natriuretic factor
(2) aldosterone
(3) ADH
(4) renin.

NEET-II 2016

21. The part of nephron involved in active reabsorption of sodium is
(1) distal convoluted tubule
(2) proximal convoluted tubule
(3) Bowman's capsule
(4) descending limb of Henle's loop.

2015 Cancelled

22. Removal of proximal convoluted tubule from the nephron will result in
(1) no change in quality and quantity of urine
(2) no urine formation
(3) more diluted urine
(4) more concentrated urine.

2015

23. Human urine is usually acidic because
(1) potassium and sodium exchange generates acidity
(2) hydrogen ions are actively secreted into the filtrate
(3) the sodium transporter exchanges one hydrogen ion for each sodium ion, in peritubular capillaries
(4) excreted plasma proteins are acidic.

2015 Cancelled

24. Which of the following does not favour the formation of large quantities of dilute urine?
(1) Renin
(2) Atrial-natriuretic factor
(3) Alcohol
(4) Caffeine

2014

25. Which of the following causes an increase in sodium reabsorption in the distal convoluted tubule?
(1) Increase in aldosterone levels
(2) Increase in antidiuretic hormone levels
(3) Decrease in aldosterone levels
(4) Decrease in antidiuretic hormone levels

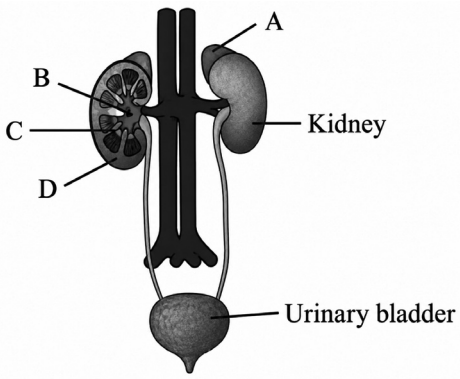
Karnataka NEET 2013

26. Select the option which shows correct matching of animal with its excretory organ and excretory product.

	Animal	**Excretory organ**	**Excretory product**
(1)	Labeo (Rohu)	Nephridial tubes	Ammonia
(2)	Salamander	Kidneys	Urea
(3)	Peacock	Kidneys	Urea
(4)	Housefly	Renal tubules	Uric acid

2013

27. Figure shows human urinary system with structures labelled A to D. Select option which correctly identifies them and gives their characteristic and/ or functions.



(1) C - Medulla - inner zone of kidney and contains complete nephrons.
(2) D - Cortex - outer part of kidney and do not contain any part of nephrons.
(3) A - Adrenal gland - located at the anterior part of kidney. Secrete catecholamines which stimulate glycogen breakdown.
(4) B - Pelvis - broad funnel shaped space inner to hilum, directly connected to loops of Henle.

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1996

52. The ornithine cycle removes two waste products from the blood in liver. These products are
(1) CO_2 and ammonia
(2) ammonia and uric acid
(3) CO_2 and urea
(4) ammonia and urea.

1994

53. Two examples in which the nitrogenous wastes are excreted from body in the form of uric acid are
(1) birds and lizards
(2) frogs and cartilaginous fish
(3) insects and bony fish
(4) mammals and molluscs.

1994

54. Which one of the four parts mentioned below does not constitute a part of single uriniferous tubule?
(1) Distal convoluted tubule
(2) Collecting duct
(3) Bowman's capsule
(4) Loop of Henle

1994

55. If excess water passes out from the tissue without being restored by the kidneys, the cells would
(1) burst open and die
(2) take water from the plasma
(3) not be affected at all
(4) shrivel and die.

1993

56. Glucose is taken back from glomerular filtrate through
(1) active transport
(2) passive transport
(3) osmosis
(4) diffusion.

1991

57. Nitrogenous waste products are eliminated mainly as
(1) urea in tadpole and ammonia in adult frog
(2) ammonia in tadpole and urea in adult frog
(3) urea in both tadpole and adult frog
(4) urea in tadpole and uric acid in adult frog.

1991

58. Under normal conditions which one is completely reabsorbed in the renal tubule?
(1) Urea (2) Uric acid
(3) Salts (4) Glucose

1990

59. Proximal and distal convoluted tubules are parts of
(1) seminiferous tubules
(2) nephron
(3) oviduct
(4) vas deferens.

1990

60. Brush border is characteristic of
(1) neck of nephron
(2) collecting tube
(3) proximal convoluted tubule
(4) all of these.

NODIA

1989

61. Reabsorption of useful substances from glomerular filtrate occurs in
(1) collecting tube
(2) loop of Henle
(3) proximal convoluted tubule
(4) distal convoluted tubule.

1988

62. Presence of RBC in urine is
(1) alkaptonuria
(2) urothiasis
(3) hematuria
(4) proteinuria.

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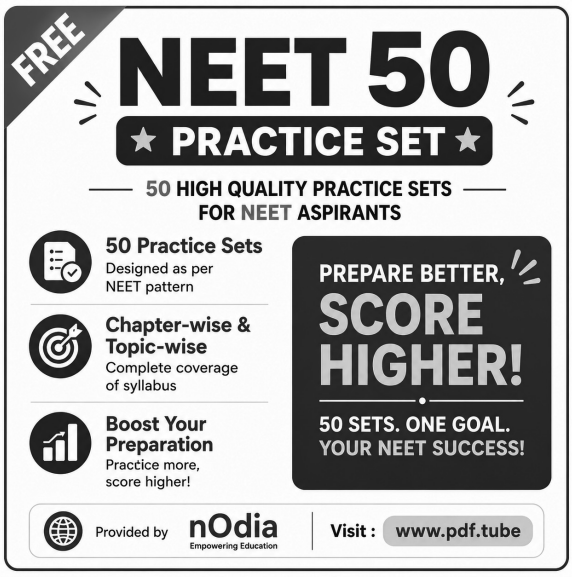

2009

38. Uric acid is the chief nitrogenous component of the excretory products of
(1) earthworm
(2) cockroach
(3) frog
(4) man.

2009

39. What will happen if the stretch receptors of the urinary bladder wall are totally removed?
(1) Micturition will continue.
(2) Urine will continue to collect normally in the bladder.
(3) There will be no micturition.
(4) Urine will not collect in the bladder.

2007

40. A person who is on a long hunger strike and is surviving only on water, will have
(1) less amino acids in his urine
(2) more glucose in his blood
(3) less urea in his urine
(4) more sodium in his urine.

2006

41. Angiotensinogen is a protein produced and secreted by
(1) juxtaglomerular (JG) cells
(2) macula densa cells
(3) endothelial cells (cells lining the blood vessels)
(4) liver cells.

2005

42. In ornithine cycle, which of the following wastes are removed from the blood?
(1) CO_2 and urea
(2) Ammonia and urea
(3) CO_2 and ammonia
(4) Urea and urine

2005

43. The net pressure gradient that causes the fluid to filter out of the glomeruli into the capsule is
(1) 50 mm Hg
(2) 75 mm Hg
(3) 20 mm Hg
(4) 30 mm Hg.

2005

44. A person is undergoing prolonged fasting. His urine will be found to contain abnormal quantities of
(1) fats
(2) amino acids
(3) glucose
(4) ketones.

2004

45. Uricotelism is found in
(1) mammals and birds
(2) fish and fresh water protozoans
(3) birds, land reptiles and insects
(4) frogs and toads.

2003

46. If Henle's loop were absent from mammalian nephron, which one of the following is to be expected?
(1) There will be no urine formation.
(2) There will be hardly any change in the quality and quantity of urine formed .
(3) The urine will be more concentrated.
(4) The urine will be more dilute.

2000

47. Conversion of ammonia to urea is done by
(1) ornithine cycle
(2) arginine cycle
(3) fumaric cycle
(4) citrulline cycle.

2000

48. Concentration of urine depends upon which organ?
(1) Bowman's capsule
(2) Length of Henle's loop
(3) PCT
(4) Network of capillaries arising from glomerulus

2000

49. A condition of failure of kidney to form urine is called
(1) anuria
(2) deamination
(3) uremia
(4) none of these.

1997

50. In ureotelic animals, urea is formed by
(1) Krebs' cycle
(2) EM pathway
(3) Ornithine cycle
(4) Cori cycle.

1997

51. The basic functional unit of human kidney is
(1) nephridia
(2) Henle's loop
(3) nephron
(4) pyramid.

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2023

12. Which of the following statements are correct?
A. An excessive loss of body fluid from the body switches off osmoreceptors.
B. ADH facilitates water reabsorption to prevent diuresis.
C. ANF causes vasodilation.
D. ADH causes increase in blood pressure.
E. ADH is responsible for decrease in GFR.
Choose the correct answer from the options given below.
(1) A, B and E only
(2) C, D and E only
(3) A and B only
(4) B, C and D only

2022

13. Nitrogenous waste is excreted in the form of pellet or paste by:
(1) Ornithorhynchus
(2) Salamandra
(3) Hippocampus
(4) Pavo

2020

14. Which of the following would help in prevention of diuresis?
(1) More water reabsorption due to undersecretion of ADH.
(2) Reabsorption of Na^+ and water from renal tubules due to aldosterone.
(3) Atrial natriuretic factor causes vasoconstriction.
(4) Decrease in secretion of renin by JG cells.

2019

15. Which of the following factors is responsible for the formation of concentrated urine?
(1) Hydrostatic pressure during glomerular filtration.
(2) Low levels of antidiuretic hormone.
(3) Maintaining hyperosmolarity towards the medullary interstitium in the kidneys.
(4) Secretion of erythropoietin by Juxtaglomerular complex.

2019

16. Use of an artificial kidney during hemodialysis may result in
A. Nitrogenous waste build-up in the body
B. Non-elimination of excess potassium ions
C. Reduced absorption of calcium ions from gastro-intestinal tract
D. Reduced RBC production.
Which of the following options is the most appropriate ?
(1) (A) and (D) are correct.
(2) (A) and (B) are correct.
(3) (B) and (C) are correct.
(4) (C) and (D) are correct.

2018

17. Match the items given in column I with those in column II and select the correct option given below.

	Column I (Function)		Column II (Part of excretory system)
A.	Ultrafiltration	(i)	Henle's loop
B.	Concentration of urine	(ii)	Ureter
C.	Transport of urine	(iii)	Urinary bladder
D.	Storage of urine	(iv)	Malpighian corpuscle
		(v)	Proximal convoluted tubule

(1) A-(iv); B-(v); C-(ii); D-(iii)
(2) A-(iv); B-(i); C-(ii); D-(iii)
(3) A-(v); B-(iv); C-(i); D-(ii)
(4) A-(v); B-(iv); C-(i); D-(iii)

2018

18. Match the items given in column I with those in column II and select the correct option given below.

	Column I (Conditions)		Column II (Descriptions)
A.	Glycosuria	(i)	Accumulation of uric acid in joints
B.	Gout	(ii)	Mass of crystallised salts within the kidney
C.	Renal calculi	(iii)	Inflammation in glomeruli
D.	Glomerular nephritis	(iv)	Presence of glucose in urine

(1) A-(iii); B-(ii); C-(iv); D-(i)
(2) A-(i); B-(ii); C-(iii); D-(iv)
(3) A-(ii); B-(iii); C-(i); D-(iv)
(4) A-(iv); B-(i); C-(ii); D-(iii)

NODIA

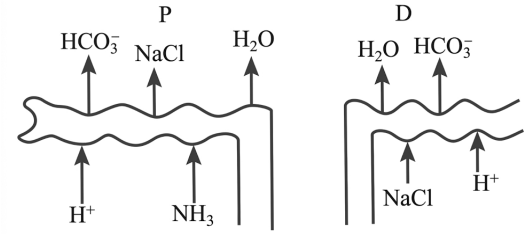
ANSWERS

1. (2) (a), (b) and (d) only
The descending limb is permeable to water but not electrolytes (a), urine becomes concentrated (b), and the ascending limb transports electrolytes (d). The ascending limb is impermeable to water, so reabsorption of water in Henle's loop (c) is incorrect.

2. (4) C, E, D, B, A
A fall in glomerular filtration rate (C) activates the JG cells to release renin, which converts angiotensinogen to angiotensin I, then II (E). Angiotensin II causes vasoconstriction and aldosterone release (D), leading to Na+ and water reabsorption (B), finally raising blood pressure and GFR (A).

3. (4) Distal convoluted tubule and afferent renal arteriole
The juxtaglomerular apparatus is a specialised structure formed by cellular modifications at the point of contact between the distal convoluted tubule and the afferent arteriole of the same nephron. It plays an important role in regulating blood pressure, glomerular filtration rate, and renin secretion.

4. (1)



The proximal convoluted tubule reabsorbs essential nutrients and electrolytes while secreting hydrogen and ammonia. The distal convoluted tubule performs conditional reabsorption of sodium and water and maintains pH by secreting potassium and hydrogen ions. Both segments play critical roles in maintaining the ionic and acid-base balance of body fluids through these physiological processes.

5. (3) Loop of Henle of juxta medullary nephron runs deep into medulla.
Juxtamedullary nephrons represent a smaller portion of total nephrons and are characterized by having their renal corpuscles located near the junction of the cortex and medulla. Their long loops of Henle extend significantly into the inner medulla. This anatomical arrangement is crucial for the kidneys' ability to produce concentrated urine via the counter-current mechanism.

6. (2) Both Statement I and Statement II are false.
The descending limb of the loop of Henle is permeable to water but almost impermeable to electrolytes, leading to filtrate concentration. The proximal convoluted tubule is lined by simple cuboidal brush border epithelium, not columnar, which provides a large surface area for the reabsorption of essential nutrients, water, and electrolytes from the primary filtrate.

NODIA

(3) Both statement I and statement II are correct.
Mammals possess the ability to produce concentrated urine through a specialized counter-current mechanism involving the loop of Henle and vasa recta. This system functions by establishing and maintaining an increasing osmotic gradient within the medullary interstitium. Such a gradient is essential for the efficient reabsorption of water from the collecting duct into the kidney tissues.

8. (4) vasopressin from neurohypophysis.
Antidiuretic hormone, also known as vasopressin, is released from the posterior pituitary gland or neurohypophysis in response to increased body fluid osmolarity. This hormone increases the permeability of the distal convoluted tubule and collecting duct to water. Enhanced water reabsorption results in a decrease in urine volume, thereby effectively preventing the condition known as diuresis.

9. (1) (A) is true but (R) is false.
Nephrons are categorized based on their structural positioning within the kidney. Cortical nephrons are located primarily in the renal cortex and possess relatively short loops of Henle. In contrast, juxtamedullary nephrons have their renal corpuscles closer to the medulla and feature long loops that extend deep into

Mains 2012

28. Which one of the following options gives the correct categorization of six animals according to the type of nitrogenous waste they give out?

	Ammonotelic	**Ureotelic**	**Uricotelic**
(1)	Pigeon, humans	Aquatic amphibia, lizards	Cockroach, frog
(2)	Frog, lizards	Aquatic amphibia, humans	Cockroach, pigeon
(3)	Aquatic amphibia	Frog, humans	Pigeon, lizards, cockroach
(4)	Aquatic amphibia	Cockroach, humans	Frog, pigeon, lizards

Mains 2012

29. Which one of the following characteristics is common both in humans and adult frogs?
(1) Four chambered heart
(2) Internal fertilisation
(3) Nucleated RBCs
(4) Ureotelic mode of excretion

2012

30. The maximum amount of electrolytes and water (70 - 80 percent) from the glomerular filtrate is reabsorbed in which part of the nephron?
(1) Ascending limb of loop of Henle
(2) Distal convoluted tubule
(3) Proximal convoluted tubule
(4) Descending limb of loop of Henle

Mains 2012

31. A fall in glomerular filtration rate (GFR) activates
(1) juxtaglomerular cells to release renin
(2) adrenal cortex to release aldosterone
(3) adrenal medulla to release adrenaline
(4) posterior pituitary to release vasopressin.

Mains 2011

32. Uricotelic mode of excreting nitrogenous wastes is found in
(1) reptiles and birds
(2) birds and annelids
(3) amphibians and reptiles
(4) insects and amphibians.

Mains 2011

33. Which one of the following is not a part of a renal pyramid?
(1) Peritubular capillaries
(2) Convoluted tubules
(3) Collecting ducts
(4) Loop of Henle

Mains 2011

34. Which one of the following correctly explains the function of a specific part of the human nephron?
(1) Podocytes : create minute spaces (slit pores) for the filtration of blood into the Bowman's capsule
(2) Henle's loop : most reabsorption of the major substances from the glomerular filtrate
(3) Distal convoluted tubule : reabsorption of K^+ ions into the surrounding blood capillaries
(4) Afferent arteriole : carries the blood away from the glomerulus towards renal vein.

Mains 2011

35. Which one of the following statements is correct with respect to kidney function regulation?
(1) When someone drinks lot of water, ADH release is suppressed.
(2) Exposure to cold temperature stimulates ADH release.
(3) An increase in glomerular blood flow stimulates formation of angiotensin II.
(4) During summer when body loses lot of water by evaporation, the release of ADH is suppressed.

2010

36. The principal nitrogenous excretory compound in humans is synthesised
(1) in kidneys but eliminated mostly through liver
(2) in kidneys as well as eliminated by kidneys
(3) in liver and also eliminated by the same through bile
(4) in the liver, but eliminated mostly through kidneys.

2010

37. Which one of the following statements in regard to the excretion by the human kidneys is correct?
(1) Descending limb of loop of Henle is impermeable to water.
(2) Distal convoluted tubule is incapable of reabsorbing HCO_3^-.
(3) Nearly 99 per cent of the glomerular filtrate is reabsorbed by the renal tubules.
(4) Ascending limb of loop of Henle is impermeable to electrolytes.

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the filtrate. In contrast, the ascending limb is impermeable to water but allows the transport of electrolytes into the medullary fluid. This difference is fundamental to the kidney's ability to concentrate urine effectively.

20. (1) atrial natriuretic factor
When blood pressure or volume decreases, the body activates the renin-angiotensin-aldosterone system and releases antidiuretic hormone to conserve water and increase pressure. Atrial natriuretic factor is a vasodilator produced by the heart atria specifically in response to an increase in blood pressure. Therefore, its release is suppressed when blood pressure falls, as it would further lower the pressure.

21. (2) proximal convoluted tubule
The proximal convoluted tubule is the primary site for the reabsorption of nearly all essential nutrients. This segment actively reabsorbs approximately seventy to eighty percent of electrolytes, including sodium ions, from the glomerular filtrate. The presence of a microvilli-lined brush border in this region significantly increases the surface area, facilitating efficient transport of these solutes back into the bloodstream.

22. (3) more diluted urine
The proximal convoluted tubule is responsible for reabsorbing the majority of water and essential solutes from the glomerular filtrate. If this segment is removed, a significant volume of water and electrolytes will remain within the tubule rather than being returned to the blood. This results in the production of a much larger volume of more diluted urine by the kidneys.

23. (2) hydrogen ions are actively secreted into the filtrate
The kidneys play a vital role in maintaining the acid-base balance of the body fluids. This is achieved through the active secretion of hydrogen ions and ammonia into the filtrate, particularly in the proximal and distal convoluted tubules. Simultaneously, bicarbonate ions are reabsorbed from the filtrate. The presence of these secreted hydrogen ions makes human urine generally acidic in nature.

24. (1) Renin
Dilute urine is formed when water reabsorption is minimized. Alcohol and caffeine act as diuretics by inhibiting the release or action of antidiuretic hormone. Atrial natriuretic factor promotes sodium excretion and water loss. However, renin initiates a hormonal cascade that leads to increased sodium and water reabsorption. Therefore, renin facilitates the production of concentrated urine and does not favor dilute urine.

NODIA

25. (1) Increase in aldosterone levels
Aldosterone is a steroid hormone produced by the adrenal cortex that regulates electrolyte balance. An increase in aldosterone levels stimulates the cells of the distal convoluted tubule and collecting duct to reabsorb more sodium ions from the filtrate. This process is usually accompanied by the osmotic reabsorption of water, which helps in maintaining blood volume and increasing systemic blood pressure.

26. (2) Salamander Kidneys Urea
Amphibians like the salamander possess kidneys for excretion and are primarily ureotelic, meaning they excrete nitrogenous waste as urea. Bony fish like Rohu are ammonotelic and excrete ammonia primarily through their gill surfaces, not kidneys or nephridia. Birds like the peacock are uricotelic and excrete uric acid. Houseflies use Malpighian tubules as their excretory organs. Thus, the combination of salamander, kidneys, and urea is correct.

27. (3) A - Adrenal gland - located at the anterior part of kidney. Secrete catecholamines which stimulate glycogen breakdown.
The adrenal glands are located on the anterior part of each kidney. They consist of an outer cortex and an inner medulla. The adrenal medulla secretes catecholamines, such as adrenaline and noradrenaline, in response to stress. These hormones facilitate the "fight or flight" response by stimulating the breakdown of glycogen into glucose to provide immediate energy for the body.

28. (3) Aquatic amphibia Frog, humans Pigeon, lizards, cockroach
Animals are classified based on their primary nitrogenous waste product. Aquatic amphibians are typically ammonotelic because ammonia requires copious water for excretion. Adult frogs and humans are ureotelic, converting ammonia to less toxic urea. Uricotelic animals, including birds like pigeons, reptiles like lizards, and

the medullary region, contrary to the incorrect statement.

10. (3) Both (A) and (R) are true and (R) is the correct explanation of (A).
The ascending limb of the loop of Henle is characterized by its impermeability to water. As the concentrated filtrate moves upward through this segment, electrolytes like sodium and chloride are transported out into the medullary fluid either actively or passively. This loss of solutes without water causes the filtrate to become increasingly diluted as it ascends.

11. (1) (C), (A), (E), (B), (D)
The regulatory process begins when a fall in glomerular blood pressure stimulates juxtaglomerular cells to release renin. Renin converts plasma angiotensinogen into angiotensin I and then to angiotensin II. Angiotensin II triggers the adrenal cortex to release aldosterone, which subsequently promotes the reabsorption of sodium and water from the distal parts of the renal tubule.

12. (4) B, C and D only
Antidiuretic hormone prevents diuresis by facilitating water reabsorption and can increase blood pressure through vasoconstriction. Atrial natriuretic factor, released by the heart, acts as a vasodilator to lower blood pressure. Conversely, excessive fluid loss activates rather than switches off osmoreceptors, and ADH generally helps to maintain or increase the glomerular filtration rate during fluid deficit.

13. (4) Pavo
Uricotelic animals, such as birds, reptiles, and land snails, excrete nitrogenous waste primarily as uric acid. This compound is relatively non-toxic and is eliminated in the form of a semi-solid pellet or paste to conserve water. Pavo, commonly known as the peacock, belongs to the class Aves and utilizes this specific water-conserving mechanism of excretion.

14. (2) Reabsorption of Na^+ and water from renal tubules due to aldosterone.
Diuresis is the excessive production of urine, which can be prevented by increasing water reabsorption. Aldosterone, secreted by the adrenal cortex, promotes the reabsorption of sodium ions and water from the distal convoluted tubules. This process increases blood volume and pressure while reducing the amount of water lost in urine, thereby maintaining the body's fluid balance.

15. (3) Maintaining hyperosmolarity towards the medullary interstitium in the kidneys.
The production of concentrated urine is achieved through a counter-current mechanism that establishes a gradient of increasing osmolarity from the cortex to the inner medulla. This hyperosmotic medullary interstitium allows for the osmotic withdrawal of water from the collecting ducts. Antidiuretic hormone further regulates this process by adjusting the permeability of the tubules to water molecules.

16. (4) (C) and (D) are correct.
Chronic renal failure often leads to reduced production of erythropoietin, the hormone responsible for stimulating red blood cell formation in the bone marrow. Additionally, the kidney's inability to convert vitamin D into its active form results in decreased calcium absorption from the intestine. Consequently, patients undergoing hemodialysis may experience anemia and impaired calcium metabolism despite the removal of wastes.

17. (2) (iv) (i) (ii) (iii)
Ultrafiltration occurs across the membranes of the Malpighian corpuscle. The loop of Henle is responsible for establishing the osmotic gradient required for the concentration of urine. Ureters serve as tubes that transport urine from the kidneys to the storage site. The urinary bladder is the muscular sac where urine is temporarily stored before being expelled through the urethra.

18. (4) (iv) (i) (ii) (iii)
Glycosuria refers to the presence of glucose in the urine, often seen in diabetes. Gout is a condition where uric acid crystals accumulate in the joints, causing inflammation. Renal calculi are hard masses formed from crystallized salts like oxalates within the kidney. Glomerular nephritis is a disease characterized by the inflammation of the glomeruli in the renal nephrons.

19. (4) The ascending limb of loop of Henle is impermeable to water.
The loop of Henle consists of two limbs with distinct permeability characteristics. The descending limb is permeable to water but impermeable to electrolytes, which concentrates

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38. (2) cockroach
Uric acid is the primary nitrogenous waste in uricotelic animals, which include insects, birds, and most reptiles. This method of excretion is highly efficient for water conservation as uric acid is excreted as a solid or semi-solid. Cockroaches, being insects, utilize Malpighian tubules to extract uric acid from their hemolymph. Earthworms are ureotelic or ammonotelic, while frogs and humans are ureotelic.

39. (3) There will be no micturition.
Micturition is the process of expelling urine from the bladder, controlled by a neural reflex. As the bladder fills, its walls stretch, activating stretch receptors that send signals to the central nervous system. The CNS then triggers the contraction of bladder muscles and relaxation of the urethral sphincter. If these stretch receptors are removed, the signal for micturition cannot be generated.

40. (3) less urea in his urine
During a prolonged hunger strike, the body initially uses stored carbohydrates and then fats for energy. Since the individual is not consuming proteins, the breakdown of amino acids for energy is reduced. Consequently, the production of ammonia and its subsequent conversion to urea in the liver decreases significantly. This leads to a lower concentration of urea being excreted in the urine.

41. (4) liver cells.
Angiotensinogen is a large alpha-globulin protein that serves as a precursor in the renin-angiotensin system. It is constitutively produced and secreted into the blood plasma primarily by the hepatocytes in the liver. When blood pressure drops, the enzyme renin, released by the kidneys, cleaves angiotensinogen to produce angiotensin I. This system is vital for the long-term regulation of blood pressure.

42. (3) CO_2 and ammonia
The ornithine cycle, also known as the urea cycle, occurs within the liver cells of ureotelic animals. In this metabolic pathway, toxic ammonia and carbon dioxide are used as substrates to synthesize urea. This conversion is essential because urea is much less toxic than ammonia and can be safely transported to the kidneys for excretion. Therefore, the cycle effectively removes these wastes.

NODIA

43. (3) 20 mm Hg
Ultrafiltration in the glomerulus is driven by a net filtration pressure. This is calculated by subtracting the opposing forces, namely blood colloidal osmotic pressure and capsular hydrostatic pressure, from the glomerular capillary blood pressure. Under typical physiological conditions, this results in a net pressure of approximately 10 to 20 mm Hg, which forces fluid out of the blood into the Bowman's capsule.

44. (4) ketones.
During prolonged fasting or starvation, the body's glycogen stores are depleted, leading to the mobilization and breakdown of fatty acids for energy. This excessive fat metabolism results in the production of ketone bodies, such as acetoacetate and beta-hydroxybutyrate. When the concentration of ketones in the blood becomes high, they are excreted by the kidneys, a condition known as ketonuria.

45. (3) birds, land reptiles and insects
Uricotelism is the excretion of nitrogenous waste in the form of uric acid. This process is characteristic of animals adapted to terrestrial environments where water conservation is critical. Since uric acid is relatively non-toxic and insoluble, it can be excreted as a paste with very little water loss. This mode of excretion is commonly observed in birds, land reptiles, and insects.

46. (4) The urine will be more dilute.
The loop of Henle is essential for creating a high osmotic concentration in the medullary interstitium through the counter-current multiplier system. This gradient allows water to be reabsorbed from the collecting ducts, leading to the production of concentrated urine. If the loop of Henle were absent, the kidney would lose its ability to concentrate urine, resulting in the excretion of dilute urine.

47. (1) ornithine cycle
The conversion of highly toxic ammonia into less toxic urea occurs in the liver via the ornithine cycle, also referred to as the urea cycle. This biochemical pathway involves several intermediate steps, including the formation of citrulline and arginine, and utilizes ornithine as a carrier molecule. This mechanism is the primary way ureotelic organisms, such as mammals, detoxify nitrogenous waste products.

Choose the most appropriate answer from the options given below.
(1) A, B & D only
(2) A, B & E only
(3) B, C & E only
(4) C, D & E only

2023

13. Which of the following statements are correct regarding skeletal muscle?
A. Muscle bundles are held together by collagenous connective tissue layer called fascicle.
B. Sarcoplasmic reticulum of muscle fibre is a store house of calcium ions.
C. Striated appearance of skeletal muscle fibre is due to distribution pattern of actin and myosin proteins.
D. M line is considered as functional unit of contraction called sarcomere.
Choose the most appropriate answer from the options given below:
(1) A, C and D only
(2) C and D only
(3) A, B and C only
(4) B and C only

Manipur NEET 2023

14. Match List I with List II.

	List I (Bones)		List II (Names)
A.	Palm bones	I.	Phalanges
B.	Wrist bones	II.	Metacarpals
C.	Ankle bones	III.	Carpals
D.	Digit bones	IV.	Tarsals

Choose the correct answer from the options given below.
(1) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
(2) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)
(3) (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
(4) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)

2023

15. Match List I with List II.

List I (Type of Joint)		List II (Found between)	
A.	Cartilaginous Joint	I.	Between flat skull bones
B.	Ball and Socket Joint	II.	Between adjacent vertebrae in vertebral column
C.	Fibrous Joint	III.	Between carpal and metacarpal of thumb
D.	Saddle Joint	IV.	Between humerus and pectoral girdle

Choose the correct answer from the options given below:
(1) A-I, B-IV, C-III, D-II
(2) A-II, B-IV, C-III, D-I
(3) A-III, B-I, C-II, D-IV
(4) A-II, B-IV, C-I, D-III

2022

16. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as reason (R).
Assertion (A) : Osteoporosis is characterised by decreased bone mass and increased chances of fractures.
Reason (R) : Common cause of osteoporosis is increased levels of estrogen.
In the light of the above statements, choose the appropriate answer from the options given below.
(1) Both (A) and (R) are correct but (R) is not the correct explanation of (A)
(2) (A) is correct but (R) is not correct
(3) (A) is not correct but (R) is correct
(4) Both (A) and (R) are correct and (R) is correct explanation of (A)

2022

17. Which of the following is a correct match for disease and its symptoms ?
(1) Arthritis-Inflammed joints
(2) Tetany - High Ca^{2+} level causing rapid spasms
(3) Myasthenia gravis - Genetic disorder resulting in weakening and paralysis of skeletal muscle
(4) Muscular dystrophy - An autoimmune disorder causing progressive degeneration of skeletal muscle

2021

18. During muscular contraction which of the following events occur?
A. 'H' zone disappears.
B. 'A' band widens.
C. 'I' band reduces in width.
D. Myosine hydrolyzes ATP, releasing the ADP and Pi.
E. Z-lines attached to actins are pulled inwards.

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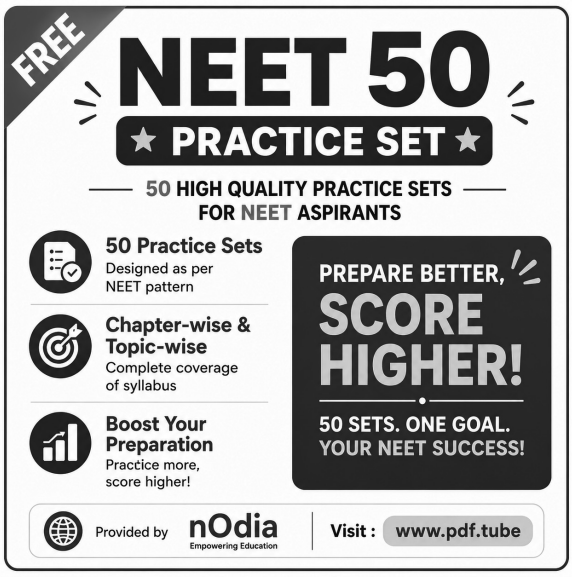
58. (4) Glucose
Under normal conditions, the renal tubules efficiently reabsorb nearly all substances essential for the body. Glucose and amino acids are completely reabsorbed from the glomerular filtrate in the proximal convoluted tubule through active transport mechanisms. In contrast, waste products like urea and uric acid are only partially reabsorbed or are actively secreted, while salts are reabsorbed according to needs.

59. (2) nephron
The proximal convoluted tubule and distal convoluted tubule are integral segments of the renal tubule within a nephron. The proximal tubule is located immediately after the Bowman's capsule and is specialized for massive reabsorption. The distal tubule follows the loop of Henle and is involved in the fine-tuning of salt and water balance and pH regulation before urine enters the duct.

60. (3) proximal convoluted tubule
A brush border is a specialized feature of certain epithelial cells, characterized by a dense covering of microvilli on their apical surface. In the kidney, this structure is found exclusively in the proximal convoluted tubule. The presence of the brush border significantly increases the internal surface area, which is essential for the efficient and rapid reabsorption of water and solutes.

61. (3) proximal convoluted tubule
The proximal convoluted tubule is the primary site for the reabsorption of useful substances from the glomerular filtrate. This includes almost all of the glucose and amino acids, as well as a large proportion of water and electrolytes. The cells of this segment are highly specialized for transport, featuring numerous mitochondria and a brush border that maximizes the efficiency of these processes.

62. (3) hematuria
Hematuria is the medical term used to describe the presence of red blood cells in the urine. This condition can be a sign of various underlying issues, such as kidney stones, infections, or trauma to the urinary tract. In a healthy individual, red blood cells are typically too large to pass through the filtration membrane of the glomerulus into the renal tubule.



NODIA

48. (2) Length of Henle's loop
The ability of the kidney to produce concentrated urine is directly related to the length of the loop of Henle. Longer loops extend deeper into the renal medulla, allowing for the establishment of a steeper osmotic gradient. This gradient facilitates greater water reabsorption from the collecting ducts. Desert mammals often have exceptionally long loops of Henle to maximize water conservation in arid environments.

49. (1) anuria
Anuria is a medical condition characterized by the failure of the kidneys to produce or excrete urine. This can be caused by various factors, including acute kidney injury, severe dehydration, or obstruction of the urinary tract. It is a critical condition that requires immediate medical attention. In contrast, uremia refers to the accumulation of urea in the blood due to kidney dysfunction.

50. (3) Ornithine cycle
In ureotelic animals, the metabolic process responsible for urea production is the ornithine cycle, which takes place in the liver. This cycle uses ammonia, produced from amino acid deamination, and combines it with carbon dioxide to form urea. Unlike the Krebs cycle, which is involved in cellular respiration, the ornithine cycle specifically functions to detoxify nitrogenous wastes for safe excretion.

51. (3) nephron
The nephron is the fundamental structural and functional unit of the human kidney. Each kidney contains approximately one million nephrons, which are responsible for filtering blood and forming urine. A nephron consists of a renal corpuscle and a renal tubule. These components work together to perform filtration, reabsorption, and secretion, ensuring the maintenance of the body's internal environment.

52. (1) CO_2 and ammonia
The ornithine cycle is a critical metabolic pathway located in the liver that detoxifies nitrogenous waste. It involves the chemical reaction of ammonia and carbon dioxide to synthesize urea. By converting these two waste products into urea, the body can safely transport and eliminate nitrogen without the high toxicity associated with ammonia. Urea is then released into the blood and filtered.

53. (1) birds and lizards
Birds and lizards are examples of uricotelic animals that excrete nitrogenous waste as uric acid. This adaptation is vital for survival in environments where water is scarce, as uric acid can be expelled with minimal water. Mammals are generally ureotelic, while most aquatic organisms like bony fish and frog tadpoles are ammonotelic. Therefore, the combination of birds and lizards is correct.

54. (2) Collecting duct
A single nephron consists of the Bowman's capsule, proximal convoluted tubule, loop of Henle, and distal convoluted tubule. While the distal tubules of several nephrons open into a common collecting duct, the duct itself is not considered a part of an individual nephron. Instead, multiple nephrons share a single collecting duct for the final processing of urine.

55. (4) shrivel and die.
If excess water is lost from the tissues and not restored by the kidneys, the extracellular fluid becomes hypertonic. This creates an osmotic pressure that draws water out of the cells and into the surrounding fluid. As a result, the cells will undergo dehydration, causing them to shrivel. If this process is severe and prolonged, it leads to cellular dysfunction and death.

56. (1) active transport
Glucose is a vital nutrient that is filtered into the Bowman's capsule but must be recovered by the body. In the proximal convoluted tubule, glucose is reabsorbed from the filtrate back into the peritubular capillaries. This process occurs via secondary active transport, specifically using sodium-glucose cotransporters. Under normal physiological conditions, all filtered glucose is reabsorbed this way, leaving none in the urine.

57. (2) ammonia in tadpole and urea in adult frog
Many amphibians change their mode of excretion during metamorphosis. Tadpoles are aquatic and excrete nitrogenous waste primarily as ammonia, as they have access to abundant water for its dilution. As they mature into adult frogs, which spend more time on land, they switch to a ureotelic mode. Adult frogs synthesize urea in their liver to conserve water and reduce toxicity.

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(3) A-IV, B-III, C-II, D-I
(4) A-III, B-II, C-I, D-IV

2025

8. Match List-I with List-II.

	List-I (Diseases)		List-II (Descriptions)
A.	Emphysema	I.	Rapid spasms in muscle due to low Ca^{2+} in body fluid
B.	Angina Pectoris	II.	Damaged alveolar walls and decreased respiratory surface
C.	Glomerulonephritis	III.	Acute chest pain when not enough oxygen is reaching to heart muscle
D.	Tetany	IV.	Inflammation of glomeruli of kidney

Choose the correct answer from the options given below.
(1) A-II, B-IV, C-III, D-I
(2) A-II, B-III, C-IV, D-I
(3) A-III, B-I, C-IV, D-II
(4) A-III, B-I, C-II, D-IV

RE-EXAM 2024

9. Select the correct statements regarding mechanism of muscle contraction.
A. It is initiated by a signal sent by CNS via sensory neuron.
B. Neurotransmitter generates action potential in the sarcolemma.
C. Increased Ca^{2+} level leads to the binding of calcium with troponin on actin filaments.
D. Masking of active site for actin is activated.
E. Utilising the energy from ATP hydrolysis to form cross bridge.
Choose the most appropriate answer from the options given below.
(1) B, C and E only
(2) C, D and E only
(3) A and D only
(4) B, D and E only

RE-EXAM 2024

10. Match List-I with List-II.

List-I (Location of joint)		List-II (Type of joint)	
A.	Joint between humerus and pectoral girdle	I.	Gliding joint
B.	Knee joint	II.	Ball and Socket joint
C.	Joint between atlas and axis	III.	Hinge joint
D.	Joint between carpels	IV.	Pivot joint

Choose the correct answer from the options given below.
(1) A-II, B-III, C-IV, D-I
(2) A-III, B-II, C-I, D-IV
(3) A-I, B-IV, C-III, D-II
(4) A-II, B-I, C-III, D-IV

2024

11. Match List I with List II.

List I (Types of Joints)		List II (Examples/Functions)	
A.	Fibrous joints	I.	Adjacent vertebrae, limited movement
B.	Cartilaginous joints	II.	Humerus and Pectoral girdle, rotational movement
C.	Hinge joints	III.	Skull, don't allow any movement
D.	Ball and socket joints	IV.	Knee, help in locomotion

Choose the correct answer from the options given below.
(1) A-IV, B-II, C-III, D-I
(2) A-I, B-III, C-II, D-IV
(3) A-II, B-III, C-I, D-IV
(4) A-III, B-I, C-IV, D-II

2024

12. Which of the following are autoimmune disorders?
A. Myasthenia gravis
B. Rheumatoid arthritis
C. Gout
D. Muscular dystrophy
E. Systemic Lupus Erythematosus (SLE)

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2009

47. Elbow joint is an example of
(1) hinge joint
(2) gliding joint
(3) ball and socket joint
(4) pivot joint.

2007

48. Which one of the following items gives its correct total number?
(1) Types of diabetes-3
(2) Cervical vertebrae in humans-8
(3) Floating ribs in humans-4
(4) Amino acids found in proteins-16

2007

49. In human body, which one of the following is anatomically correct?
(1) Collar bones - 3 pairs
(2) Salivary glands - 1 pair
(3) Cranial nerves - 10 pairs
(4) Floating ribs - 2 pairs

2006

50. The contractile protein of skeletal muscle involving ATPase activity is
(1) troponin
(2) tropomyosin
(3) myosin
(4) α-actinin.

2005

51. An acromion process is characteristically found in the
(1) pelvic girdle of mammals
(2) pectoral girdle of mammals
(3) skull of frog
(4) sperm of mammals.

2005

52. Which of the following pairs is correctly matched?
(1) Hinge joint - Between vertebrae
(2) Gliding joint - Between zygapophyses of the successive vertebrae
(3) Cartilaginous joint - Skull bones
(4) Fibrous joint - Between phalanges

2002

53. What will happen if ligaments are torn ?
(1) Bones will move freely at joint and no pain.
(2) Bone less movable at joint and pain.
(3) Bone will become unfixed.
(4) Bone will become fixed.

2001

54. Which statement is correct for muscle contraction?
(1) Length of H-zone decreases.
(2) Length of A-band remains constant.
(3) Length of I-band increases.
(4) Length of two Z-line increases.

2001

55. What is sarcomere?
(1) Part between two H-line
(2) Part between two A-line
(3) Part between two I-band
(4) Part between two Z-line

2000

56. Sternum is connected to ribs by
(1) bony matter
(2) white fibrous cartilage
(3) hyaline cartilage
(4) areolar tissue.

2000

57. Bone related with skull is
(1) coracoid
(2) arytenoid
(3) pterygoid
(4) atlas.

2000

58. What is the name of joint between ribs and sternum?
(1) Cartilaginous joint
(2) Angular joint
(3) Gliding joint
(4) Fibrous joint

NODIA

1999

59. The joint between atlas and axis is called
(1) angular joint
(2) hinge joint
(3) pivot joint
(4) saddle joint.

1998

60. Which of the following is the contractile protein of a muscle?
(1) Tropomyosin
(2) Tubulin
(3) Myosin
(4) All of these

1998

61. The functional unit of contractile system in striated muscle is
(1) sarcomere
(2) Z-band
(3) cross bridges
(4) myofibril.

Choose the correct answer from the options given below.
(1) (B), (D), (E), (A) only
(2) (A), (C), (D), (E) only
(3) (A), (B), (C), (D) only
(4) (B), (C), (D), (E) only

2021

19. Match List-I with List-II.

List-I (Bones/Structures)		List-II (Type/Feature)	
(p)	Scapula	(i)	Cartilaginous joints
(q)	Cranium	(ii)	Flat bone
(r)	Sternum	(iii)	Fibrous joints
(s)	Vertebral column	(iv)	Triangular flat bone

Choose the correct answer from the options given below.
(1) (p)-(iv); (q)-(iii); (r)-(ii); (s)-(i)
(2) (p)-(i); (q)-(iii); (r)-(ii); (s)-(iv)
(3) (p)-(ii); (q)-(iii); (r)-(iv); (s)-(i)
(4) (p)-(iv); (q)-(ii); (r)-(iii); (s)-(i)

2021

20. Chronic autoimmune disorder affecting neuro muscular junction leading to fatigue, weakening and paralysis of skeletal muscle is called as
(1) gout
(2) arthritis
(3) muscular dystrophy
(4) myasthenia gravis.

2020

21. Match the following columns and select the correct option.

	Column I		Column II
(A)	Floating ribs	(i)	Located between second and seventh ribs
(B)	Acromion	(ii)	Head of the humerus
(C)	Scapula	(iii)	Clavicle
(D)	Glenoid cavity	(iv)	Do not connect with the sternum

(1) (A)-(ii); (B)-(iv); (C)-(i); (D)-(iii)
(2) (A)-(i); (B)-(iii); (C)-(ii); (D)-(iv)
(3) (A)-(iii); (B)-(ii); (C)-(iv); (D)-(i)
(4) (A)-(iv); (B)-(iii); (C)-(i); (D)-(ii)

2019

22. Select the correct option.
(1) There are seven pairs of vertebrosternal, three pairs of vertebrochondral and two pairs of vertebral ribs.
(2) 8th, 9th and 10th pairs of ribs articulate directly with the sternum.
(3) 11th and 12th pairs of ribs are connected to the sternum with the help of hyaline cartilage.
(4) Each rib is a flat thin bone and all the ribs are connected dorsally to the thoracic vertebrae and ventrally to the sternum.

Odisha NEET 2019

23. Match the following joints with the bones involved:

	List-I (Joints)		List-II (Location)
(1)	Gliding joint	(i)	Between carpal and metacarpal of thumb
(2)	Hinge joint	(ii)	Between atlas and axis
(3)	Pivot joint	(iii)	Between the carpals
(4)	Saddle joint	(iv)	Between humerus and ulna.

Select the correct option from the following:
(1) (1)-(iii), (2)-(iv), (3)-(ii), (4)-(i)
(2) (1)-(iv), (2)-(i), (3)-(ii), (4)-(iii)
(3) (1)-(iv), (2)-(ii), (3)-(iii), (4)-(i)
(4) (1)-(i), (2)-(iii), (3)-(ii), (4)-(iv)

2019

24. Which of the following muscular disorders is inherited?
(1) Botulism
(2) Building
(3) Muscular dystrophy
(4) Myasthenia gravis

2018

25. Calcium is important in skeletal muscle contraction because it
(1) binds to troponin to remove the masking of active sites on actin for myosin
(2) activates the myosin ATPase by binding to it
(3) detaches the myosin head from the actin filament
(4) prevents the formation of bonds between the myosin cross bridges and the actin filament.

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CHAPTER 17
Locomotion and Movement

2026 (RE-NEET)

1. The number of vertebrae in a human is:
(1) 26
(2) 206
(3) 7
(4) 12

2026 (RE-NEET)

2. Which represents the correct sequence of arrangement of bones in the lower limb of humans?
(1) Femur-patella-tibia-tarsal
(2) Femur-tarsal-patella-tibia
(3) Femur-tibia-patella-tarsal
(4) Patella-femur-tibia-tarsal

2026 (RE-NEET)

3. Which is the correct order of arrangement of vertebral column from the head to toe?
(1) Cervical, lumbar, thoracic, sacrum
(2) Cervical, thoracic, lumbar, sacrum
(3) Cervical, thoracic, sacrum, lumbar
(4) Sacrum, lumbar, thoracic, cervical

2026 (RE-NEET)

4. Muscle contraction is initiated by a signal sent by the central nervous system by the release of ___.
(1) cyclic guanine monophosphate
(2) cyclic adenine monophosphate
(3) acetyl choline
(4) acetyl coenzyme A

2026 (CANCELLED)

5. Choose the correct statements regarding muscle contraction:
A. A motor neuron carries a signal sent by the Central Nervous System (CNS) to the sarcolemma of the muscle fibre.
B. The neural signal generates an action potential which causes the release of Ca_2^+ into sarcoplasm.
C. Increase in Ca_2^+ inactivates the actin for breaking cross bridges.
D. Actin binds to the myosin head to form a cross bridge.
E. Shortening of sarcomere takes place, by pulling actin filaments towards the centre of 'A' band.
Choose the correct answer from the options given below :
(1) C and D only
(2) A and B only
(3) C and E only
(4) A, B, D and E only

2026 (CANCELLED)

6. Which of the following statements are correct with reference to human endoskeleton?
A. Human skull is monocondylic.
B. The joint between any two adjoining vertebrae is a cartilaginous joint.
C. In human beings, the number of cervical vertebrae is seven.
D. All ribs except the last 2 pairs are bicephalic.
E. The occipital bone of skull is articulated with atlas vertebra.
Choose the correct answer from the options given below:
(1) B and E only
(2) B, C and E only
(3) C, D and E only
(4) A, B and D only

2026 (CANCELLED)

7. Match List I with List II related to muscular/ skeletal system:
List I:
A. Tetany
B. Arthritis
C. Myasthenia gravis
D. Muscular dystrophy
List II:
I. Inflammation of joints
II. Autoimmune disorder affecting neuromuscular junction
III. Wild contraction in muscle due to low Ca^{++} in body fluid
IV. Progressive degeneration of skeletal muscle
(1) A-III, B-I, C-II, D-IV
(2) A-I, B-II, C-III, D-IV

NODIA

(4) the central gap between myosin filaments in the A-band.

Karnataka NEET 2013

38. During muscle contraction in humans, the
(1) sarcomere does not shorten
(2) A band remains same
(3) A, H and I bands shorten
(4) actin filaments shorten.

2013

39. The characteristic and an example of a synovial joint in humans is

	Characteristics	Examples
(1)	Fluid filled synovial cavity between two bones	Joint between atlas and axis
(2)	Lymph filled between two bones, limited movement	Gliding joint between carpals
(3)	Fluid cartilage between two bones, limited movements	Knee joint
(4)	Fluid filled between two joints, provides cushion	Skull bones

2013

40. Select the correct statement with respect to locomotion in humans.
(1) The vertebral column has 10 thoracic vertebrae.
(2) The joint between adjacent vertebrae is a fibrous joint.
(3) A decreased level of progesterone causes osteoporosis in old people.
(4) Accumulation of uric acid crystals in joints causes their inflammation.

Karnataka NEET 2013

41. Select the correct statement with respect to disorders of muscles in humans.
(1) Failure of neuromuscular transmission in myasthenia gravis can prevent normal swallowing.
(2) Accumulation of urea and creatine in the joints causes their inflammation.
(3) An overdose of vitamin D causes osteoporosis.
(4) Rapid contractions of skeletal muscles cause muscle dystrophy.

2012

42. Select the correct statement regarding the specific disorder of muscular or skeletal system.
(1) Muscular dystrophy - Age related shortening of muscles
(2) Osteoporosis - Decrease in bone mass and higher chances of fractures with advancing age
(3) Myasthenia gravis - Autoimmune disorder which inhibits sliding of myosin filaments
(4) Gout - Inflammation of joints due to extra deposition of calcium

2011

43. The type of muscle present in our
(1) heart is involuntary and unstriated smooth muscle
(2) intestine is striated and involuntary
(3) thigh is striated and voluntary
(4) upper arm is smooth muscle and fusiform in shape.

2011

44. Three of the following pairs of the human skeletal parts are correctly matched with their respective inclusive skeletal category and one pair is not matched. Identify the non-matching pair.

	Pair of skeletal parts	Category
(1)	Sternum and ribs	Axial skeleton
(2)	Clavicle and glenoid cavity	Pelvic girdle
(3)	Humerus and ulna	Appendicular skeleton
(4)	Malleus and stapes	Ear ossicles

2010

45. Which one of the following is the correct description of a certain part of a normal human skeleton?
(1) Parietal bone and the temporal bone of the skull are joined fibrous joint.
(2) First vertebra is axis which articulates with the occipital condyles.
(3) The 9th and 10th pairs of ribs are called the floating ribs.
(4) Glenoid cavity is a depression to which the thigh bone articulates.

2009

46. Which one of the following is the correct matching of three items and their grouping category?

	Items	Group
(1)	Ilium, ischium, pubis	Coxal bones of pelvic girdle
(2)	Actin, myosin, rhodopsin	Muscle proteins
(3)	Cytosine, uracil, thiamine	Pyrimidines
(4)	Malleus, incus, cochlea	Ear ossicles

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2017

26. Out of 'X' pairs of ribs in humans only 'Y' pairs are true ribs. Select the option that correctly represents values of X and Y and provides their explanation.
(1) X = 12, Y = 5 True ribs are attached dorsally to vertebral column and sternum on the two ends
(2) X = 24, Y = 2 The true ribs are dorsally attached to vertebral column but are free on ventral side
(3) X = 24, Y = 12 True ribs are dorsally attached to vertebral column but are free on ventral side
(4) X = 12, Y = 7 True ribs are attached dorsally to vertebral column and ventrally to the sternum

2017

27. The pivot joint between atlas and axis is a type of
(1) cartilaginous joint (2) synovial joint
(3) saddle joint (4) fibrous joint.

NEET-II 2016

28. Name the ion responsible for unmasking of active sites for myosin for cross-bridge activity during muscle contraction.
(1) Calcium (2) Magnesium
(3) Sodium (4) Potassium

NEET-I 2016

29. Lack of relaxation between successive stimuli in sustained muscle contraction is known as
(1) tetanus (2) tonus
(3) spasm (4) fatigue.

NEET-II 2016

30. Osteoporosis, an age-related disease of skeletal system, may occur due to
(1) immune disorder affecting neuromuscular junction leading to fatigue
(2) high concentration of Ca^{2+} and Na^{+}
(3) decreased level of estrogen
(4) accumulation of uric acid leading to inflammation of joints.

2015 Cancelled

31. Sliding filament theory can be best explained as
(1) actin and myosin filaments do not shorten but rather slide pass each other
(2) when myofilaments slide pass each other, myosin filaments shorten while actin filaments do not shorten
(3) when myofilaments slide pass each other actin filaments shorten while myosin filaments do not shorten
(4) actin and myosin filaments shorten and slide pass each other.

2015

32. Which of the following is not a function of the skeletal system?
(1) Production of body heat
(2) Locomotion
(3) Production of erythrocytes
(4) Storage of minerals

2015 Cancelled

33. Glenoid cavity articulates
(1) clavicle with scapula
(2) humerus with scapula
(3) clavicle with acromion
(4) scapula with acromion.

2015

34. Which of the following joints would allow no movements?
(1) Synovial joint
(2) Ball and socket joint
(3) Fibrous joint
(4) Cartilaginous joint

2014

35. Stimulation of a muscle fibre by a motor neuron occurs at
(1) the neuro-muscular junction
(2) the transverse tubules
(3) the myofibril
(4) the sacroplasmic reticulum.

2014

36. Select the correct matching of the type of the joint with the example in human skeletal system.

	Type of joint		Example
(1)	Cartilaginous joint	-	Between frontal and parietal
(2)	Pivot joint	-	Between third and fourth cervical vertebrae
(3)	Hinge joint	-	Between humerus and pectoral girdle
(4)	Gliding joint	-	Between carpals

NODIA

2013

37. The H-zone in the skeletal muscle fibre is due to
(1) the central gap between actin filaments extending through myosin filaments in the A-band
(2) extension of myosin filaments in the central portion of the A-band
(3) the absence of myofibrils in the central portion of A-band

1998

62. Total number of bones in each limb of a man is
(1) 24 (2) 30
(3) 14 (4) 21.

1996

63. When a muscle bends one part upon the other, it is called
(1) abductor (2) regulator
(3) extremor (4) flexor.

1995

64. The number of floating ribs in the human body is
(1) 3 pairs
(2) 2 pairs
(3) 6 pairs
(4) 5 pairs.

1994

65. Which of the following components is a part of the pectoral girdle?
(1) Sternum
(2) Acetabulum
(3) Glenoid cavity
(4) Ilium

1994

66. The type of joint between the human skull bones is called
(1) cartilaginous joint
(2) hinge joint
(3) fibrous joint
(4) synovial joint.

1993

67. The cervical vertebrae in human is
(1) same as in whale
(2) more than that in rabbit
(3) double than that of horse
(4) less than that in giraffe.

1993

68. Long bones function in
(1) support
(2) support, erythrocyte and leucocyte synthesis
(3) support and erythrocyte synthesis
(4) erythrocyte formation.

1993

69. Number of cervical vertebrae in camel is
(1) more than that of rabbit
(2) less than that of rabbit
(3) same as that of whale
(4) more than that of horse.

1990

70. A deltoid ridge occurs in
(1) radius
(2) ulna
(3) femur
(4) humerus.

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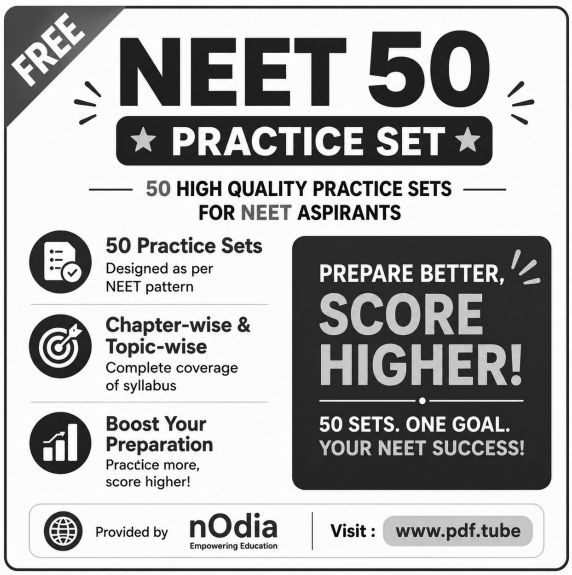

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22. (1) There are seven pairs of vertebrosternal, three pairs of vertebrochondral and two pairs of vertebral ribs.
In the human thoracic cage, the first seven pairs of ribs are true ribs that attach directly to the sternum. The eighth, ninth, and tenth pairs are false ribs that connect to the seventh rib via hyaline cartilage. The final two pairs are floating ribs, which have no ventral attachment. This distribution provides structural integrity while allowing for necessary respiratory movements.

23. (1) (1)-(iii), (2)-(iv), (3)-(ii), (4)-(i)
Gliding joints are found between the carpals, allowing sliding movements. Hinge joints occur between the humerus and ulna, facilitating angular motion like a door. The pivot joint between the atlas and axis allows the head to rotate. The saddle joint is specifically located between the carpal and metacarpal of the thumb, enabling its unique range of motion and grip.

24. (3) Muscular dystrophy
Muscular dystrophy is a group of inherited diseases characterized by the progressive weakening and breakdown of skeletal muscles over time. It is caused by genetic mutations that interfere with the production of muscle proteins needed to form healthy tissue. In contrast, botulism is caused by toxins, and myasthenia gravis is an autoimmune condition, making muscular dystrophy the primary inherited muscular disorder.

25. (1) binds to troponin to remove the masking of active sites on actin for myosin
Calcium ions play a fundamental role in the sliding filament mechanism of muscle contraction. When a nerve impulse reaches the muscle, calcium is released from the sarcoplasmic reticulum. These ions bind to the troponin complex located on the actin filaments. This binding causes a conformational change that unmasks the myosin-binding sites on actin, allowing cross-bridge formation and subsequent contraction.

26. (4) X = 12, Y = 7 True ribs are attached dorsally to vertebral column and ventrally to the sternum
Humans possess twelve pairs of ribs in total, which form the protective thoracic cage. Out of these, the first seven pairs are classified as true ribs. They are defined by their dual attachment points: dorsally to the thoracic vertebrae and ventrally directly to the sternum via costal cartilage. The remaining ribs are either false or floating, lacking this direct connection.

27. (2) synovial joint
The pivot joint located between the first cervical vertebra, known as the atlas, and the second, called the axis, is a type of synovial joint. Synovial joints are characterized by a fluid-filled cavity that allows for significant movement. This specific pivot arrangement is what enables the rotational motion of the human head, distinguishing it from fibrous or cartilaginous joint types.

28. (1) Calcium
Calcium ions are the primary chemical trigger for muscle contraction. Upon stimulation, these ions are released into the sarcoplasm where they bind to troponin. This interaction induces a structural change in the tropomyosin-troponin complex, which unmasks the active sites on the actin filaments. Once these sites are exposed, myosin heads can attach and pull the actin filaments to initiate contraction.

NODIA

29. (1) tetanus
Tetanus in muscle physiology refers to a state of sustained contraction that occurs when stimuli are delivered at a high frequency. At this rate, the muscle fiber does not have enough time to relax between successive stimulations. This results in the individual twitches fusing together into a continuous, powerful contraction, which is distinct from muscle fatigue or a simple spasm.

30. (3) decreased level of estrogen
Osteoporosis is a skeletal disorder characterized by reduced bone density and structural deterioration. It is an age-related condition that frequently affects post-menopausal women. This is because the decline in estrogen levels during menopause leads to an imbalance in bone remodeling, where bone resorption exceeds bone formation. Consequently, bones become brittle and more susceptible to fractures during normal daily activities.

31. (1) actin and myosin filaments do not shorten but rather slide pass each other
The sliding filament theory explains how muscles contract without the individual protein filaments changing their actual length. Instead, actin filaments slide over the stationary myosin filaments toward the center of the sarcomere.

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causing skeletal muscle weakness. Rheumatoid arthritis is a chronic inflammatory autoimmune disease affecting the joints. Systemic Lupus Erythematosus is also an autoimmune condition impacting various organs. Gout results from uric acid accumulation, and muscular dystrophy is typically a genetic disorder, making neither of them autoimmune in nature.

13. (4) B and C only
The sarcoplasmic reticulum within skeletal muscle fibers serves as a critical storage site for calcium ions necessary for contraction. The characteristic striated appearance of these muscles is created by the organized distribution of actin and myosin proteins. Muscle bundles are called fascicles and are held together by fascia. The sarcomere, the functional unit, is bounded by two Z-lines.

14. (4) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
The human skeletal system organizes bones into specific regions for functional movement. Metacarpals constitute the palm of the hand, while carpals form the wrist. In the lower limb, tarsals make up the ankle region. Phalanges are the bones that comprise the digits of both the hands and feet. This systematic arrangement allows for complex manipulation and stable bipedal locomotion.

15. (4) A-II, B-IV, C-I, D-III
Cartilaginous joints connect adjacent vertebrae in the vertebral column, permitting limited movement. Ball and socket joints link the humerus to the pectoral girdle for broad rotation. Fibrous joints are immovable sutures found between flat skull bones. Saddle joints, specifically located between the carpal and metacarpal of the thumb, provide the unique mobility required for an opposable grip.

16. (2) (A) is correct but (R) is not correct
Osteoporosis is an age-related condition defined by a significant reduction in bone mass, which increases the likelihood of fractures. This condition is primarily driven by hormonal changes, specifically a decrease in estrogen levels rather than an increase. Estrogen plays a vital role in maintaining bone density, and its deficiency leads to excessive bone resorption and structural skeletal weakening.

17. (1) Arthritis-Inflammed joints
Arthritis is clinically defined as the inflammation of one or more joints, leading to pain and stiffness. Tetany is actually caused by low calcium levels resulting in spasms. Myasthenia gravis is an autoimmune condition, not purely genetic. Muscular dystrophy is a genetic disorder causing progressive muscle degeneration, while the description provided for it incorrectly refers to an autoimmune mechanism.

18. (2) (A), (C), (D), (E) only
During muscle contraction, the sarcomere shortens as actin filaments slide over myosin. This process causes the H-zone to disappear and the I-band to reduce in width. The Z-lines are pulled inwards, shortening the overall fiber. Energy for this process comes from myosin hydrolyzing ATP into ADP and inorganic phosphate. Notably, the width of the A-band remains completely constant.

19. (1) (iv) (iii) (ii) (i)
The scapula is a large triangular flat bone situated in the dorsal part of the thorax. The cranium consists of bones joined by immovable fibrous joints. The sternum is a flat bone located on the ventral midline of the thorax. The vertebral column contains cartilaginous joints between adjacent vertebrae, allowing for limited movement while providing structural support for the body.

20. (4) myasthenia gravis.
Myasthenia gravis is a chronic autoimmune neuromuscular disease that affects the transmission of nerve impulses to muscles. It specifically targets the acetylcholine receptors at the neuromuscular junction. This leads to symptoms such as progressive fatigue, muscle weakness, and eventually paralysis of skeletal muscles. Unlike gout or arthritis, this disorder is fundamentally rooted in a failure of the autoimmune system.

21. (4) (iv) (iii) (i) (ii)
Floating ribs are the last two pairs of ribs that do not connect ventrally to the sternum. The acromion is a flat bony process that articulates with the clavicle. The scapula is a triangular bone located dorsally between the second and seventh ribs. The glenoid cavity is a shallow depression in the scapula that receives the head of the humerus.

NODIA

61. (1) sarcomere
The sarcomere is recognized as the functional and structural unit of contraction in striated muscle fibers. It consists of highly organized thick and thin filaments arranged between two Z-lines. During contraction, these filaments slide over each other, leading to the shortening of each sarcomere along the length of the myofibril. This collective shortening results in the contraction of the entire muscle fiber and muscle.

62. (2) 30
Each limb in a human being, whether an arm or a leg, contains exactly thirty bones. In the upper limb, this includes the humerus, radius, ulna, eight carpals, five metacarpals, and fourteen phalanges. In the lower limb, it consists of the femur, tibia, fibula, patella, seven tarsals, five metatarsals, and fourteen phalanges. This consistency reflects the organized nature of the appendicular skeleton.

63. (4) flexor.
A flexor is a type of muscle that, when contracted, decreases the angle between two bones at a joint, effectively bending one part of the body toward another. This action is the opposite of an extensor, which increases the angle and straightens the limb. Flexors are essential for complex movements such as bending the elbow or the knee during various physical and locomotive activities.

64. (2) 2 pairs
In the human body, the rib cage consists of twelve pairs of ribs. The 11th and 12th pairs are specifically termed floating ribs. They are called so because they have no ventral attachment to the sternum or to other ribs. Instead, they are attached only dorsally to the thoracic vertebrae, providing protection to the kidneys while allowing for significant trunk flexibility.

65. (3) Glenoid cavity
The glenoid cavity is an essential component of the pectoral girdle, specifically located on the scapula. It serves as the socket that receives the head of the humerus to form the shoulder joint. The acetabulum and ilium are parts of the pelvic girdle, while the sternum is part of the axial skeleton. Therefore, only the glenoid cavity belongs to the pectoral girdle.

66. (3) fibrous joint
Fibrous joints are characterized by the absence of a joint cavity and do not allow any significant movement between the bones. In the human skull, these joints appear as sutures where the flat bones are held together firmly by dense fibrous connective tissue. This structural arrangement provides essential protection for the brain by ensuring the skull remains a rigid and protective container.

67. (1) same as in whale
Almost all mammals, including humans, whales, rabbits, horses, and giraffes, possess exactly seven cervical vertebrae in their neck region. This anatomical feature remains consistent across diverse mammalian species regardless of their overall size or neck length. Therefore, the number of cervical vertebrae in a human is identical to that found in a whale, reflecting a common and conserved evolutionary trait.

68. (2) support, erythrocyte and leucocyte synthesis
Long bones, such as the femur and humerus, serve multiple vital functions in the human body. They provide structural support and act as levers for movement. Crucially, the red bone marrow found within the ends of these bones is the site of hematopoiesis, where both red blood cells, known as erythrocytes, and white blood cells, known as leucocytes, are synthesized.

69. (3) same as that of whale
The number of cervical vertebrae is a highly conserved characteristic among mammals. Whether it is a camel with a long neck, a whale with a short neck, or a human, they all typically have seven cervical vertebrae. This consistency exists because the length of the neck is determined by the length of the individual vertebrae rather than by changing the total count.

70. (4) humerus.
The deltoid ridge, also known as the deltoid tuberosity, is a rough, triangular area located on the lateral surface of the middle of the shaft of the humerus. This anatomical feature serves as the primary site of attachment for the deltoid muscle. This muscle is responsible for the abduction of the arm, making the deltoid ridge essential for upper limb movement.

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This sliding motion reduces the distance between Z-lines, effectively shortening the sarcomere and the muscle fiber as a whole, while the thick and thin filaments remain constant.

32. (1) Production of body heat
The skeletal system provides structural support, facilitates locomotion by acting as levers, stores essential minerals like calcium, and produces blood cells in the bone marrow. However, the production of body heat is not a primary function of the skeleton. Heat generation is a metabolic byproduct of muscle activity and contraction, which is handled by the muscular system during movement.

33. (2) humerus with scapula
The glenoid cavity is a shallow, pyriform articular surface located on the lateral angle of the scapula. It functions specifically to receive the head of the humerus, forming the glenohumeral or shoulder joint. This ball and socket arrangement provides the most extensive range of motion of any joint in the human body, allowing for versatile upper limb movement.

34. (3) fibrous joint
Fibrous joints are characterized by bones being joined together by dense fibrous connective tissue without a joint cavity. These joints are functionally classified as synarthroses because they allow virtually no movement. Common examples include the sutures between the flat bones of the human skull. This lack of mobility ensures a stable and protective structure for delicate internal organs like the brain.

35. (1) the neuro-muscular junction
Stimulation of a muscle fiber occurs when a signal from a motor neuron reaches the neuromuscular junction. This specialized synapse is where the axon terminal of a motor neuron meets the sarcolemma of a muscle fiber. The release of the neurotransmitter acetylcholine into the synaptic cleft triggers an action potential in the muscle, initiating the complex sequence of muscle contraction.

36. (4) Gliding joint - Between carpals
Gliding joints occur between bones with flat surfaces, such as the carpals in the wrist, allowing them to slide past each other. Cartilaginous joints exist between vertebrae, not between frontal and parietal skull bones, which have fibrous joints. Pivot joints are found between the atlas and axis. Hinge joints are found at the knee or elbow, not the shoulder joint.

37. (1) the central gap between actin filaments extending through myosin filaments in the A-band
In a relaxed skeletal muscle fiber, the H-zone is the central portion of the thick myosin filaments in the A-band that is not overlapped by thin actin filaments. This creates a visible gap between the ends of the actin filaments. When the muscle contracts, the actin filaments slide toward the center, causing the H-zone to narrow and eventually disappear completely.

38. (2) A band remains same
During muscle contraction, the sarcomere shortens because actin filaments slide over myosin filaments toward the center. While the I-band and H-zone reduce in width as the degree of overlap increases, the length of the filaments themselves does not change. Consequently, the A-band, which corresponds to the full length of the thick myosin filaments, remains constant in its width throughout contraction.

NODIA

39. (1) Fluid filled synovial cavity between two bones Joint between atlas and axis
Synovial joints are defined by the presence of a fluid-filled cavity between articulating bones, which reduces friction and allows for free movement. The pivot joint between the atlas and axis is a prime example of this joint type. Other examples include hinge and ball and socket joints. In contrast, skull bones are joined by fibrous tissue, which does not allow movement.

40. (4) Accumulation of uric acid crystals in joints causes their inflammation.
Gout is a form of inflammatory arthritis caused by the accumulation of uric acid crystals within the joints. This condition leads to redness, swelling, and intense pain. Other statements are incorrect because the vertebral column has twelve thoracic vertebrae, the joints between vertebrae are cartilaginous, and osteoporosis in older people is primarily linked to decreased levels of estrogen rather than progesterone.

41. (1) Failure of neuromuscular transmission in myasthenia gravis can prevent normal swallowing.
Myasthenia gravis is an autoimmune disorder that compromises the transmission of nerve

(3) Limbic system & hypothalamus
(4) Corpora quadrigemina & hippocampus

2022

8. Select the incorrect statement regarding synapses.
(1) The membranes of presynaptic and postsynaptic neurons are in close proximity in an electrical synapse.
(2) Electrical current can flow directly from one neuron into the other across the electrical synapse.
(3) Chemical synapses use neurotransmitters.
(4) Impulse transmission across a chemical synapse is always faster than that across an electrical synapse.

2019

9. Which part of the brain is responsible for thermoregulation?
(1) Medulla oblongata
(2) Cerebrum
(3) Hypothalamus
(4) Corpus callosum

2018

10. Nissl's bodies are mainly composed of
(1) proteins and lipids
(2) DNA and RNA
(3) nucleic acids and SER
(4) free ribosomes and RER.

2018

11. Which of the following structures or regions is incorrectly paired with its functions?
(1) Medulla oblongata : Controls respiration and cardiovascular reflexes
(2) Limbic system : Consists of fibre tracts that interconnect different regions of brain, controls movement
(3) Hypothalamus : Production of releasing hormones and regulation of temperature, hunger and thirst
(4) Corpus callosum: Band of fibers connecting left and right cerebral hemispheres

2017

12. Myelin sheath is produced by
(1) astrocytes and Schwann cells
(2) oligodendrocytes and osteoclasts
(3) osteoclasts and astrocytes
(4) Schwann cells and oligodendrocytes.

2017

13. Receptor sites for neurotransmitters are present on
(1) pre-synaptic membrane
(2) tips of axons
(3) post-synaptic membrane
(4) membranes of synaptic vesicles.

2015 Cancelled

14. Which of the following regions of the brain is incorrectly paired with its function?
(1) Corpus callosum - communication between the left and right cerebral cortices
(2) Cerebrum - calculation and contemplation
(3) Medulla oblongata - homeostatic control
(4) Cerebellum - language comprehension

2014

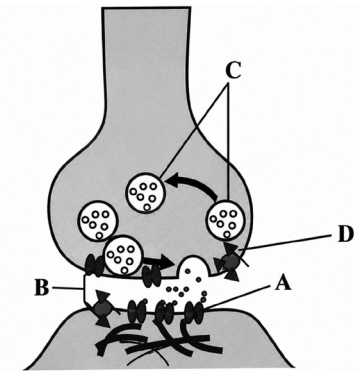
15. Injury localized to the hypothalamus would most likely disrupt
(1) short - term memory
(2) co-ordination during locomotion
(3) executive functions, such as decision making
(4) regulation of body temperature.

2013

16. The most abundant intracellular cation is
(1) H^+
(2) K^+
(3) Na^+
(4) Ca^{2+}

2013

17. A diagram showing axon terminal and synapse is given. Identify correctly at least two of A - D.



(1) A - Neurotransmitter, B - Synaptic cleft
(2) C - Neurotransmitter, D - Ca^{2+}
(3) A - Receptor, C - Synaptic vesicles
(4) B - Synaptic connection, D - K^+

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51. (2) pectoral girdle of mammals
The acromion process is a prominent bony projection found on the scapula, which is a key component of the pectoral girdle in mammals. It extends laterally and articulates with the clavicle to form the acromioclavicular joint. This structure provides a point of attachment for various muscles of the shoulder and arm, playing a vital role in upper body mobility and strength.

52. (2) Gliding joint - Between zygapophyses of the successive vertebrae
Gliding joints, which allow bones to slide over one another, are found between the zygapophyses of adjacent vertebrae. Hinge joints are found at the knee or elbow, not between vertebrae. Cartilaginous joints are found between vertebral bodies, while skull bones are connected by fibrous joints. Fibrous joints are immovable sutures, not found between phalanges, which possess synovial hinge joints for movement.

53. (2) Bone less movable at joint and pain.
Ligaments are tough, fibrous connective tissues that connect bones to other bones at a joint, providing stability and limiting excessive movement. If ligaments are torn, the joint loses its structural integrity and support. This results in significant pain and instability, making the joint far less movable or functional than normal. Without proper ligamentous support, coordinated and pain-free movement becomes impossible.

54. (2) Length of A-band remains constant.
During muscle contraction, the sliding filament model explains that thick and thin filaments slide past each other without changing their individual lengths. The A-band corresponds to the entire length of the thick myosin filaments, and thus its width remains constant. In contrast, the H-zone and I-band shorten, and the distance between the two Z-lines decreases as the sarcomere contracts.

55. (4) Part between two Z-line
A sarcomere is the fundamental functional unit of a skeletal muscle fiber. It is defined as the segment of a myofibril located between two successive Z-lines. Each sarcomere contains a full A-band and half of two I-bands. The shortening of these individual units through the sliding of actin and myosin filaments is what results in the overall contraction of the entire muscle.

NODIA

56. (3) hyaline cartilage
In the human thoracic cage, the ribs are connected to the sternum through costal cartilages. These cartilages are made of hyaline cartilage, which is a flexible and resilient type of connective tissue. This specific connection allows the rib cage to expand and contract during the process of breathing, providing both necessary structural support and the flexibility required for effective pulmonary ventilation.

57. (3) pterygoid
The pterygoid bone is a specific skeletal element associated with the skull, particularly in the region of the sphenoid bone. It provides surfaces for the attachment of muscles involved in jaw movement. Coracoid is part of the pectoral girdle, atlas is the first cervical vertebra, and arytenoid is a cartilage located in the larynx, making pterygoid the bone related to skull anatomy.

58. (1) Cartilaginous joint
The joints between the ribs and the sternum are classified as cartilaginous joints because the bones are joined by costal cartilage. These joints allow for a small amount of movement, which is essential for the expansion of the chest during inhalation. Unlike fibrous joints which are immovable or synovial joints which are freely movable, cartilaginous joints provide limited flexibility suitable for respiratory mechanics.

59. (3) pivot joint
The articulation between the first cervical vertebra, the atlas, and the second cervical vertebra, the axis, is a pivot joint. This specialized joint allows the atlas to rotate around the odontoid process of the axis. This specific type of synovial joint movement is what enables the human head to turn from side to side in a “no” motion, providing essential rotational mobility.

60. (3) Myosin
Myosin is a primary contractile protein found in muscle tissues. It forms the thick filaments of the myofibril and interacts with actin to generate the force required for muscle contraction. While tropomyosin and troponin are involved in the regulation of contraction, myosin is the actual molecular motor that utilizes chemical energy from ATP to produce mechanical work and shorten the muscle fiber.

signals at the neuromuscular junction by blocking acetylcholine receptors. This leads to profound muscle weakness, which can affect the muscles used for swallowing and breathing. Inflammation of joints, known as gout, is caused by uric acid, not urea or creatine. Osteoporosis is linked to hormonal changes, not vitamin D overdose.

42. (2) Osteoporosis - Decrease in bone mass and higher chances of fractures with advancing age
Osteoporosis is an age-related skeletal disorder where bone mineral density decreases, making the bones fragile and prone to fractures. It is commonly associated with reduced estrogen levels in older women. Myasthenia gravis is an autoimmune disease affecting neuromuscular junctions, not just myosin sliding. Gout is caused by uric acid deposition, and muscular dystrophy is a genetic condition, not just age-related muscle shortening.

43. (3) thigh is striated and voluntary
Skeletal muscles, such as those found in the thigh, are characterized by a striated appearance and are under voluntary control by the somatic nervous system. Cardiac muscle in the heart is striated but involuntary. The smooth muscles found in the walls of the intestine and other internal organs are non-striated and involuntary, and are typically spindle-shaped rather than being organized like thigh muscles.

44. (2) Clavicle and glenoid cavity Pelvic girdle
The clavicle and the glenoid cavity of the scapula are components of the pectoral girdle, which attaches the upper limbs to the axial skeleton. They do not belong to the pelvic girdle, which consists of the coxal bones. Other pairs are correctly matched: the sternum and ribs belong to the axial skeleton, limb bones are appendicular, and ear ossicles include the malleus.

45. (1) Parietal bone and the temporal bone of the skull are joined fibrous joint.
The flat bones of the human skull, including the parietal and temporal bones, are connected by sutures which are a type of immovable fibrous joint. The first vertebra is actually the atlas, which articulates with the occipital condyles. Ribs 11 and 12 are the floating ribs. The glenoid cavity articulates with the humerus, while the femur articulates with the acetabulum.

46. (1) Ilium, ischium, pubis Coxal bones of pelvic girdle
The human pelvic girdle is formed by two coxal bones, each resulting from the fusion of the ilium, ischium, and pubis bones. These three parts comprise the skeletal structure of the hip. Actin and myosin are muscle proteins, but rhodopsin is a visual pigment. Cytosine and uracil are pyrimidines, but thiamine is a vitamin. Cochlea is part of the inner ear.

47. (1) hinge joint
The elbow joint is a classic example of a hinge joint, where the articular surfaces allow movement in primarily one plane, similar to the mechanism of a door hinge. This joint connects the distal end of the humerus with the proximal ends of the radius and ulna. This structural arrangement facilitates the flexion and extension of the forearm during various physical activities.

48. (3) Floating ribs in humans-4
Humans have twelve pairs of ribs, and the last two pairs are known as floating ribs because they do not attach ventrally to the sternum. This results in a total of four floating ribs. There are seven cervical vertebrae, not eight. There are twenty common amino acids found in proteins. Diabetes is generally classified into two main types, Type 1 and Type 2.

49. (4) Floating ribs - 2 pairs
In human anatomy, the 11th and 12th pairs of ribs are called floating ribs because they are not attached ventrally to the sternum. This means there are exactly two pairs. Humans have one pair of collar bones, three pairs of salivary glands, and twelve pairs of cranial nerves. Therefore, the presence of two pairs of floating ribs is the only anatomically correct statement.

50. (3) myosin
Myosin is the thick filament protein in skeletal muscle that acts as a molecular motor. It possesses an inherent ATPase activity located in its globular head region. This activity allows myosin to hydrolyze ATP, releasing energy that is used to bind to actin and perform the power stroke. Troponin and tropomyosin are regulatory proteins, while actinin helps anchor the filaments to Z-discs.

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CHAPTER 18
Neural Control and Coordination

2026 (RE-NEET)

1. Which of the following is not a part of human central neural system?
(1) Pia mater
(2) Pericardium
(3) Arachnoid
(4) Dura mater

2026 (CANCELLED)

2. The specific receptors for neurotransmitters in a synapse are present on:
(1) Schwann cell
(2) Pre-synaptic membrane
(3) Myelin sheath
(4) Post-synaptic membrane

RE-EXAM 2024

3. Match List-I with List-II.

	List-I		List-II
A.	Schwann cells	I.	Neurotransmitter
B.	Synaptic knob	II.	Cerebral cortex
C.	Bipolar neurons	III.	Myelin sheath
D.	Multipolar neurons	IV.	Retina

Choose the correct answer from the options given below.
(1) A-III, B-I, C-IV, D-II
(2) A-I, B-IV, C-II, D-III
(3) A-IV, B-III, C-II, D-I
(4) A-II, B-III, C-I, D-IV

2024

4. Match List I with List II

List I (Brain Parts)		List II (Functions)	
A.	Pons	I.	Provides additional space for neurons, regulates posture and balance.
B.	Hypothalamus	II.	Controls respiration and gastric secretions.
C.	Medulla	III.	Connects different regions of the brain.
D.	Cerebellum	IV.	Neurosecretory cells

Choose the correct answer from the options given below.
(1) A-II, B-III, C-I, D-IV
(2) A-III, B-IV, C-II, D-I
(3) A-I, B-III, C-II, D-IV
(4) A-II, B-I, C-III, D-IV

2024

5. Given below are two statements :
Statement I : The cerebral hemispheres are connected by nerve tract known as corpus callosum.
Statement II : The brain stem consists of the medulla oblongata, pons and cerebrum.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Both Statement I and Statement II are correct
(2) Both Statement I and Statement II are incorrect.
(3) Statement I is correct but Statement II is incorrect.
(4) Statement I is incorrect but Statement II is correct.

NODIA

Manipur NEET 2023

6. Brainstem of human brain consists of
(1) Mid-brain, Pons and Medulla oblongata
(2) Forebrain, Cerebellum and Pons
(3) Thalamus, Hypothalamus and Corpora quadrigemina
(4) Amygdala, Hippocampus and Corpus callosum.

2023

7. The parts of human brain that helps in regulation of sexual behaviour, expression of excitement, pleasure, rage, fear etc. are:
(1) Brain stem & epithalamus
(2) Corpus callosum and thalamus

ANSWERS

1. (1) 26
The human vertebral column consists of 26 vertebrae in adults: 7 cervical, 12 thoracic, 5 lumbar, 1 sacrum (fused from 5) and 1 coccyx (fused from 4). 206 is the total number of bones, not the vertebrae.

2. (1) Femur-patella-tibia-tarsal
From above downward the bones are femur (thigh bone), patella (knee cap), tibia (shin bone), then the tarsals (ankle bones). This proximal-to-distal order matches femur-patella-tibia-tarsal.

3. (2) Cervical, thoracic, lumbar, sacrum
From head to toe, the vertebral column is arranged as cervical (neck), thoracic (chest), lumbar (lower back), then the sacrum, followed by the coccyx. This corresponds to cervical, thoracic, lumbar, sacrum.

4. (3) acetyl choline
Muscle contraction begins when a motor neuron releases the neurotransmitter acetylcholine at the neuromuscular junction. Acetylcholine generates an action potential in the sarcolemma, leading to Ca_2^+ release and contraction.

5. (4) A, B, D and E only
A motor neuron carries the CNS signal to the sarcolemma (A), generating an action potential that releases Ca_2^+ into the sarcoplasm (B). Actin binds the myosin head forming cross bridges (D), and the sarcomere shortens as actin slides towards the A band centre (E). Statement C is incorrect, since Ca_2^+ activates contraction.

6. (2) B, C and E only
The joints between adjoining vertebrae are cartilaginous (B correct). Humans have seven cervical vertebrae (C correct). The occipital bone articulates with the atlas vertebra (E correct). The human skull is dicondylic, not monocondylic (A wrong), and all ribs are bicephalic, not just some (D wrong).

7. (1) A-III, B-I, C-II, D-IV
Tetany is caused by rapid muscle contractions due to low Ca2+ in body fluid (III). Arthritis is inflammation of joints (I). Myasthenia gravis is an autoimmune disorder affecting the neuromuscular junction (II). Muscular dystrophy is progressive degeneration of skeletal muscle (IV), giving A-III, B-I, C-II, D-IV.

8. (2) A-II, B-III, C-IV, D-I
Emphysema is a chronic respiratory disorder where alveolar walls are damaged, reducing the surface area for gas exchange. Angina pectoris involves acute chest pain due to inadequate oxygen supply to the heart muscles. Glomerulonephritis refers to the inflammation of kidney glomeruli. Tetany is characterized by rapid muscle spasms caused by low calcium levels in the body fluid.

9. (1) B, C and E only
Muscle contraction begins when the central nervous system sends a signal via motor neurons. This releases neurotransmitters that generate an action potential in the sarcolemma. Consequently, calcium ions are released and bind to troponin, removing the masking of active sites on actin. ATP hydrolysis then provides the energy required for myosin heads to form cross bridges with actin.

10. (1) A-II, B-III, C-IV, D-I
The joint between the humerus and the pectoral girdle is a ball and socket joint allowing multi-directional movement. The knee joint is a hinge joint restricted to back-and-forth motion. The connection between the atlas and axis is a pivot joint enabling rotation. Gliding joints occur between the carpals in the wrist, allowing bones to slide over each other.

11. (4) A-III, B-I, C-IV, D-II
Fibrous joints in the skull are immovable, providing structural protection. Cartilaginous joints between adjacent vertebrae allow for limited flexibility and movement in the spine. Hinge joints found in the knee facilitate locomotion through simple angular movement. Ball and socket joints, such as those between the humerus and pectoral girdle, provide a wide range of rotational and multi-axial movement.

12. (2) A, B & E only
Myasthenia gravis is an autoimmune disorder where antibodies attack neuromuscular junctions,

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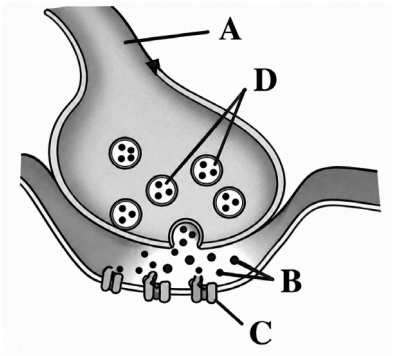
Karnataka NEET 2013

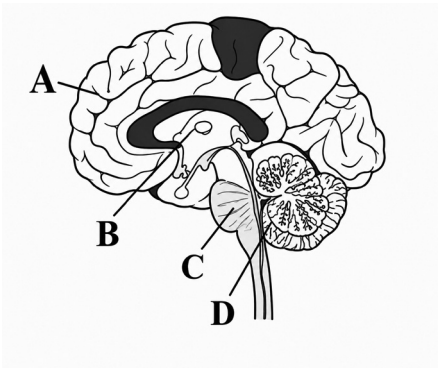
18. The figure shows an axon terminal and synapse. Select the option giving correct identification of labels A-D.



(1) A-Action potential, C-Neurotransmitter
(2) B-Neurotransmitter, D-Receptor capsules
(3) C-Receptor, D-Synaptic vesicles
(4) A-Axon terminal, B- Serotonin complex

Karnataka NEET 2013

19. A sagittal section of human brain is shown here. Identify at least two labels from A-D.



(1) C-Midbrain, D-Cerebellum
(2) A-Cerebrum, C-Pons
(3) B-Corpus callosum, D-Medulla
(4) A-Cerebral hemispheres, B-Cerebellum

2012

20. The human hind brain comprises three parts, one of which is
(1) spinal cord
(2) corpus callosum
(3) cerebellum
(4) hypothalamus.

2011

21. When a neuron is in resting state i.e., not conducting any impulse, the axonal membrane is
(1) comparatively more permeable to Na^+ ions and nearly impermeable to K^+ ions
(2) equally permeable to both Na^+ and K^+ ions
(3) impermeable to both Na^+ and K^+ ions
(4) comparatively more permeable to K^+ ions and nearly impermeable to Na^+ ions.

2010

22. The nerve centres which control the body temperature and the urge for eating are contained in
(1) hypothalamus
(2) pons
(3) cerebellum
(4) thalamus.

2009

23. Alzheimer's disease in humans is associated with the deficiency of
(1) glutamic acid
(2) acetylcholine
(3) gamma aminobutyric acid (GABA)
(4) dopamine.

2009

24. Which part of human brain is concerned with the regulation of body temperature?
(1) Cerebellum
(2) Cerebrum
(3) Hypothalamus
(4) Medulla oblongata

2008

25. During the propagation of a nerve impulse, the action potential results from the movement of
(1) K^+ ions from intracellular fluid to extracellular fluid
(2) Na^+ ions from extracellular fluid to intracellular fluid
(3) K^+ ions from extracellular fluid to intracellular fluid
(4) Na^+ ions from intracellular fluid to extracellular fluid.

2007

26. During the transmission of nerve impulse through a nerve fibre, the potential on the inner side of the plasma membrane has which type of electric charge?
(1) First positive, then negative and continue to be negative
(2) First negative, then positive and continue to be positive
(3) First positive, then negative and again back to positive
(4) First negative, then positive and again back to negative.

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CHAPTER 19
Chemical Coordination and Integration

2026 (RE-NEET)

1. Which one of the following statements is incorrect?
(1) Glucagon stimulates glycogenolysis
(2) β-cells of pancreas secrete insulin
(3) α-cells of pancreas secrete glucagon
(4) α-cells of pancreas secrete insulin

2026 (RE-NEET)

2. Which statements related to pituitary gland are correct?
(a) Divided into adenohypophysis and neurohypophysis;
(b) Secretes FSH;
(c) Secretes MSH;
(d) Does not secrete prolactin.
Choose the correct answer from the options given below:
(1) (c) and (d) only
(2) (b) and (c) only
(3) (a) and (b) only
(4) (a), (b) and (c) only

2026 (RE-NEET)

3. Match List-I with List-II:
List-I
A. Excess growth hormone;
B. Luteinizing hormone;
C. Vasopressin;
D. Oxytocin.
List-II
I. Reabsorption of water and electrolytes in kidney,
II. Contraction of uterus during child birth,
III. Acromegaly,
IV. Ovulation)
(1) A-II, B-IV, C-I, D-III
(2) A-IV, B-III, C-I, D-II
(3) A-III, B-IV, C-II, D-I
(4) A-III, B-IV, C-I, D-II

2026 (CANCELLED)

4. Match List I with List II:
List I:
A. Cortisol
B. Aldosterone
C. Cholecystokinin
D. Progesterone
List II:
I. Stimulates the formation of alveoli in mammary glands
II. Produces anti-inflammatory reactions
III. Stimulates reabsorption of Na+ and water from renal tubule
IV. Stimulates secretion of pancreatic enzymes and bile juice
Choose the correct answer from the options given below :
(1) A-III, B-II, C-IV, D-I
(2) A-IV, B-II, C-I, D-III
(3) A-II, B-III, C-IV, D-I
(4) A-II, B-III, C-I, D-IV

2025

5. Match List-I with List-II.

List-I (Hormones)		List-II (Source/Location)	
A.	Progesterone	I.	Pars intermedia
B.	Relaxin	II.	Ovary
C.	Melanocyte stimulating hormone	III.	Adrenal Medulla
D.	Catecholamines	IV.	Corpus luteum

Choose the correct answer from the options given below.
(1) A-II, B-IV, C-I, D-III
(2) A-III, B-II, C-IV, D-I
(3) A-IV, B-II, C-I, D-III
(4) A-IV, B-II, C-III, D-I

2025

6. Consider the following statements regarding function of adrenaly medullary hormones:
A. It causes pupilary constriction.
B. It is a hyperglycemic hormone.
C. It causes piloerection.
D. It increases strength of heart contraction.
Choose the correct answer from the options given below.
(1) A, C and D Only (2) D Only
(3) C and D Only (4) B, C and D Only

NODIA

1996

41. By which nervous system and of what type, the blood is supplied into visceral organs?
(1) Both SNS and PNS, involuntary
(2) Para-sympathetic nervous system, involuntary
(3) Sympathetic nervous system, involuntary
(4) Sympathetic nervous system, voluntary

1995

42. The sympathetic nerves, in mammals, arise from
(1) sacral nerves
(2) 3rd, 7th, 9th and 10th cranial nerves
(3) thoraco-lumbar nerves
(4) cervical nerves.

1992

43. Afferent nerve fibres carry impulses from
(1) effector organs to CNS
(2) receptors to CNS
(3) CNS to receptors
(4) CNS to muscles

1992

44. Vagus nerve is
(1) X
(2) IX
(3) VII
(4) V

1990

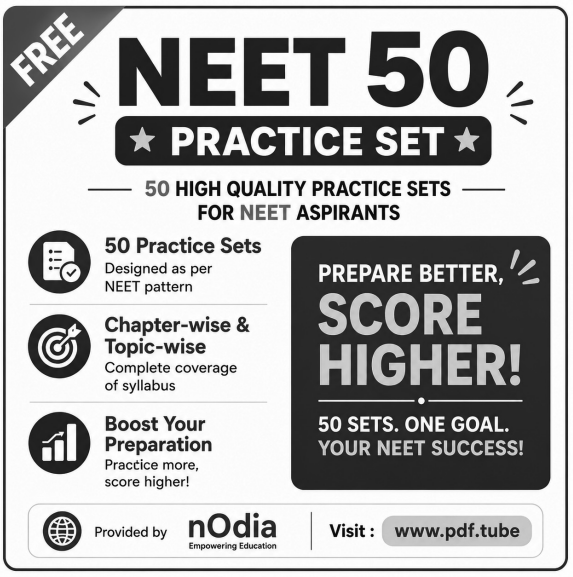
45. One function of parasympathetic nervous system is
(1) contraction of hair muscles
(2) stimulation of sweat glands
(3) acceleration of heart beat
(4) constriction of pupil.

1990

46. Third ventricle of brain is also known as
(1) metacoel
(2) rhinocoel
(3) paracoel
(4) diacoel.

1989

47. Which of the following cranial nerves can regulate heart beat?
(1) X
(2) IX
(3) VIII
(4) VII



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is crucial for communication within the nervous system, as it enables electrical or chemical signals to pass across the gap, ensuring information flow.

38. (1) Neurons
Neurons are the fundamental structural and functional units of the entire nervous tissue. These specialized cells are capable of detecting, receiving, and transmitting various types of stimuli as electrical impulses. While other components like axons, dendrites, and myelin sheaths are essential parts or supports for these cells, the neuron itself represents the basic unit that performs the essential processing and signaling tasks.

39. (3) 10
The vagus nerve is the tenth pair of cranial nerves in the human body. It is a mixed nerve, containing both sensory and motor fibers that provide extensive innervation to the heart, lungs, and digestive organs. As a major component of the parasympathetic nervous system, it plays a critical role in controlling involuntary functions and maintaining homeostasis across multiple internal organ systems.

40. (3) ribosome
Nissl's granules are distinct granular structures located within the cell body and dendrites of neurons. They are primarily composed of ribosomes and rough endoplasmic reticulum. These organelles are the sites of intense protein synthesis, which is required for the maintenance of the neuron and the production of neurotransmitters. Their discovery was significant in understanding the high metabolic activity of nerve cells.

41. (1) Both SNS and PNS, involuntary
The blood supply to visceral organs is managed by the autonomic nervous system, which operates under involuntary control. Both the sympathetic and parasympathetic divisions play roles in regulating the diameter of blood vessels and the overall flow to these organs. This dual innervation allows the body to adjust blood distribution based on current needs, such as digestion during rest or increased demand during activity.

42. (3) thoraco-lumbar nerves
In mammals, the sympathetic nervous system originates from the middle region of the spinal cord. The preganglionic neurons arise from the thoracic and upper lumbar segments, leading to its classification as the thoraco-lumbar outflow. These nerves extend from the spinal cord to ganglia, from where postganglionic fibers then travel to various target organs throughout the body to initiate the fight-or-flight response.

43. (2) receptors to CNS
Afferent nerve fibers, also known as sensory fibers, are responsible for carrying electrical impulses from various sensory receptors throughout the body toward the central nervous system. These receptors detect changes in the internal or external environment and convert them into signals. This pathway allows the brain and spinal cord to process sensory information, such as touch, pain, or temperature, and initiate appropriate responses.

NODIA

44. (1) X
The vagus nerve is the tenth cranial nerve and is commonly represented by the Roman numeral X. It is a major component of the parasympathetic nervous system and is unique because it travels far from the brain to reach organs in the thorax and abdomen. It regulates vital involuntary functions, including the rhythm of the heart, the process of digestion, and the respiratory rate.

45. (4) constriction of pupil.
The parasympathetic nervous system is responsible for the body's rest-and-digest functions. One of its specific actions is the constriction of the pupil, which occurs to protect the eye from excessive light and to facilitate near vision. Other effects include slowing the heart rate and increasing digestive activity. These responses help conserve energy and maintain long-term bodily health, contrasting with the sympathetic system's actions.

46. (4) diacoel.
The human brain contains several interconnected, fluid-filled cavities called ventricles that circulate cerebrospinal fluid. The third ventricle is a narrow, slit-like space located in the center of the diencephalon. It is also known as the diacoel. This ventricle is situated between the two thalami and plays a role in protecting the brain from injury and transporting nutrients and waste products within the system.

other homeostatic processes like hunger, thirst, and sleep.

10. (4) free ribosomes and RER.
Nissl's bodies are distinct granular structures found within the cell body and dendrites of neurons. They are primarily composed of rough endoplasmic reticulum and free ribosomes, making them highly active sites for protein synthesis. These proteins are essential for the maintenance, repair, and overall functional integrity of the neuron, supporting the continuous production of enzymes and structural components needed.

11. (2) Limbic system : Consists of fibre tracts that interconnect different regions of brain, controls movement
The limbic system is mainly involved in regulating emotional expressions, memory, and sexual behavior, rather than being primarily responsible for movement control. It includes structures such as the hippocampus and amygdala. The description of interconnecting fiber tracts better fits the pons. In contrast, the medulla, hypothalamus, and corpus callosum are correctly matched with their respective functions in homeostasis and communication.

12. (4) Schwann cells and oligodendrocytes.
The myelin sheath is a fatty layer that provides electrical insulation for axons, increasing the speed of impulse conduction. In the peripheral nervous system, this sheath is produced by Schwann cells. In the central nervous system, specialized cells called oligodendrocytes perform this function. Both cell types wrap their plasma membranes around the axon to create the protective and functional myelinated layer.

13. (3) post-synaptic membrane
During synaptic transmission, neurotransmitters are released from the pre-synaptic neuron into the narrow gap called the synaptic cleft. These chemical messengers then travel across the cleft to reach the receiving neuron. Specific receptor sites are located on the post-synaptic membrane, where these neurotransmitters bind. This binding event triggers a response in the second neuron, allowing the nerve impulse to continue.

14. (4) Cerebellum - language comprehension
The cerebellum is primarily responsible for coordinating voluntary movements, maintaining posture, and ensuring equilibrium. Language comprehension is actually a function of specialized regions within the cerebral cortex, such as Wernicke's area, rather than the cerebellum. Other pairings, like the cerebrum for complex thought and the medulla for homeostatic control, are correct, as they accurately reflect the established roles of these regions.

15. (4) regulation of body temperature.
The hypothalamus contains specialized centers that act as the body's primary thermostat, maintaining a stable internal temperature. It coordinates various physiological responses to heat and cold to ensure homeostasis. An injury to this specific region would severely disrupt the body's ability to regulate its temperature. While other brain areas handle memory and movement, the hypothalamus is essential for thermoregulatory control.

16. (2) K^+
Potassium ions are the most abundant positively charged ions found within the intracellular fluid of cells. They play a fundamental role in establishing the resting membrane potential of neurons and are vital for various cellular metabolic activities. While sodium and calcium ions are also important, they are typically found in much higher concentrations in the extracellular fluid surrounding the cells of the body.

17. (3) A - Receptor, C - Synaptic vesicles
In the structure of a synapse, synaptic vesicles are small sacs located within the axon terminal that store neurotransmitters. When an electrical impulse arrives, these vesicles release their chemical contents into the synaptic cleft. These chemicals then bind to specific receptor molecules located on the membrane of the post-synaptic neuron. This interaction is essential for the successful transmission of the nerve signal.

18. (3) C-Receptor, D-Synaptic vesicles
Synaptic vesicles are organelles within the axon terminal that hold chemical neurotransmitters. Upon the arrival of an action potential, these vesicles fuse with the membrane to release their contents into the synaptic gap. Receptors are specialized proteins situated on the post-synaptic membrane that bind to these released chemicals. This process is necessary for converting chemical signals back into electrical impulses in neurons.

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19. (2) A-Cerebrum, C-Pons
In a sagittal section of the human brain, several major structures can be identified. The cerebrum is the largest part, responsible for higher cognitive functions, sensory perception, and voluntary motor control. The pons is a distinct part of the hindbrain that serves as a bridge, connecting various regions and assisting in the regulation of vital processes like breathing and signal relay.

20. (3) cerebellum
The hindbrain is one of the three main divisions of the brain and is located at the posterior. It consists of three specific parts: the pons, the medulla oblongata, and the cerebellum. The cerebellum is particularly important for coordinating motor movements, maintaining balance, and ensuring posture. Other structures like the hypothalamus and corpus callosum are parts of the forebrain, not the hindbrain.

21. (4) comparatively more permeable to K^+ ions and nearly impermeable to Na^+ ions.
When a neuron is at rest, its axonal membrane shows selective permeability to different ions. The membrane is much more permeable to potassium ions than to sodium ions because more potassium leak channels are open. Additionally, the membrane is impermeable to negatively charged proteins inside the cell. These factors work together to maintain the negative electrical charge characteristic of the resting membrane potential.

22. (1) hypothalamus
The hypothalamus is a vital region of the forebrain that contains several centers responsible for maintaining homeostasis. It houses the nerve centers that control body temperature by initiating responses like sweating or shivering. Furthermore, it contains specialized areas that regulate the urge for eating and drinking. By integrating sensory information, the hypothalamus ensures that the body's basic physiological needs are met.

23. (2) acetylcholine
Alzheimer's disease is a progressive neurodegenerative disorder that primarily affects memory and cognitive functions in humans. Research has shown that this condition is significantly associated with a deficiency of acetylcholine, a neurotransmitter essential for learning and memory processes. The decline in acetylcholine levels results from the degeneration of specific neurons, leading to the characteristic symptoms of confusion and severe memory loss.

24. (3) Hypothalamus
The hypothalamus is the primary brain region responsible for the regulation of body temperature. It acts as a biological thermostat by sensing the temperature of the blood and receiving input from thermoreceptors. When the temperature fluctuates, the hypothalamus triggers mechanisms to either conserve or dissipate heat. This function is critical for maintaining the internal stability required for the body's metabolic processes to work.

25. (2) Na^+ ions from extracellular fluid to intracellular fluid
The generation of an action potential during nerve impulse propagation is primarily caused by the rapid movement of sodium ions. When a stimulus reaches a neuron, voltage-gated sodium channels open, allowing sodium ions to rush from the extracellular fluid into the intracellular fluid. This influx of positive charge causes the membrane to depolarize, creating the electrical signal that travels along the axon.

26. (4) First negative, then positive and again back to negative.
A resting nerve fiber maintains a negative charge on the inner side of its membrane. During the transmission of an impulse, the influx of sodium ions causes the inner side to become briefly positive, a process known as depolarization. To restore the resting state, potassium ions then move out of the cell, making the inner side negative again. This sequence is essential for signaling.

27. (1) Cortisone
Neurotransmitters are chemical substances, like acetylcholine, epinephrine, and norepinephrine, that transmit signals across the synapses between neurons. Cortisone, however, is a corticosteroid hormone produced by the adrenal cortex. It primarily functions in regulating metabolism, reducing inflammation, and managing the body's stress response. Unlike the other substances mentioned, cortisone does not serve as a direct signaling molecule for synaptic communication within the nervous system.

NODIA

28. (1) Movement of the eyeball
The abducens nerve is the sixth cranial nerve and is strictly a motor nerve. Its primary function is to innervate the lateral rectus muscle, which is responsible for rotating the eyeball outward, away from the nose. If the abducens nerve is injured, this specific muscle becomes paralyzed, leading to an inability to move the eye laterally and potentially causing double vision.

29. (3) dopamine
Parkinson's disease is a neurodegenerative disorder characterized by motor symptoms such as tremors, stiffness, and slowed movement. This condition is caused by the progressive loss of neurons in the brain that produce dopamine. Dopamine is a critical neurotransmitter involved in the control of smooth and coordinated muscle activity. The resulting lack of dopamine disrupts the normal signaling required for effective motor function.

30. (1) tongue movements
The vagus nerve is the tenth cranial nerve and provides extensive parasympathetic innervation to many internal organs. It regulates involuntary functions such as heart rate, pancreatic secretion, and gastrointestinal motility. However, tongue movements are primarily controlled by the hypoglossal nerve, which is the twelfth cranial nerve. Therefore, an injury to the vagus nerve would affect internal organ functions but not the motor control of the tongue.

31. (3) Na^+ into the cell
In the resting state, there is a higher concentration of sodium ions outside the neural membrane compared to the inside. Because of this concentration gradient, sodium ions would naturally diffuse into the cell if the membrane allowed it. Conversely, potassium ions are more concentrated inside and would move out. The sodium-potassium pump actively works against these gradients to maintain the necessary resting membrane potential.

32. (3) ribosomes
Nissl's granules are large, granular structures found in the cytoplasm of neurons. They are now identified as clusters of rough endoplasmic reticulum and ribosomes. Their presence indicates high levels of protein synthesis within the cell body and dendrites. These proteins are necessary for various neuronal functions, including the repair of the cell and the production of enzymes required for neurotransmitter synthesis.

33. (2) Myelin sheath is discontinuous.
The node of Ranvier is a specific gap found at regular intervals along the length of a myelinated axon. At these locations, the insulating myelin sheath is discontinuous, leaving the axonal membrane exposed. This structural arrangement is essential for saltatory conduction, where the nerve impulse jumps between nodes, significantly increasing the speed and efficiency of electrical signal transmission along the nerve fiber.

34. (2) Na^+ move inside and K^+ move more outside
Depolarization during nerve conduction is triggered by a sudden increase in the membrane's permeability to sodium ions. This causes sodium ions to rush into the cell, reversing the electrical charge across the axolemma. Immediately following this influx, potassium ions begin to move out of the cell to initiate the repolarization process. This coordinated movement of ions is essential for the propagation of the nerve impulse.

35. (1) Vagus nerve
The vagus nerve is the tenth cranial nerve and is remarkable for its extensive distribution and complexity. It has the highest number of branches among all cranial nerves because it innervates various organs in the head, neck, thorax, and abdomen. These branches allow it to regulate a wide range of autonomic functions, including heart rate, digestion, and respiratory processes throughout the body.

36. (2) heart beat
The sympathetic nervous system is a division of the autonomic nervous system that prepares the body for stressful situations, often called the fight-or-flight response. One of its primary actions is to increase the heart rate to enhance blood delivery to muscles. In contrast, it generally inhibits activities like the secretion of digestive juices and saliva, which are handled by the thickness of the saliva and the parasympathetic system.

37. (4) a synapse.
A synapse is the specialized junction that allows for the transmission of signals between two neurons. It typically occurs between the axon terminal of the sending neuron and the dendrite or cell body of the receiving neuron. This site

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2006

27. Which one of the following does not act as a neurotransmitter?
(1) Cortisone
(2) Acetylcholine
(3) Epinephrine
(4) Norepinephrine

2005

28. In a man, abducens nerve is injured. Which one of the following functions will be affected?
(1) Movement of the eyeball
(2) Movement of the tongue
(3) Swallowing
(4) Movement of the neck

2005

29. Parkinson's disease (characterized by tremors and progressive rigidity of limbs) is caused by degeneration of brain neurons that are involved in movement control and make use of neurotransmitter
(1) acetylcholine
(2) norepinephrine
(3) dopamine
(4) GABA.

2004

30. Injury to vagus nerve in humans is not likely to affect
(1) tongue movements
(2) gastrointestinal movements
(3) pancreatic secretion
(4) cardiac movements.

2004

31. In the resting state of the neural membrane, diffusion due to concentration gradients, if allowed, would drive
(1) K^+ into the cell
(2) K^+ and Na^+ out of the cell
(3) Na^+ into the cell
(4) Na^+ out of the cell.

2003

32. What used to be described as Nissl's granules in a nerve cell are now identified as
(1) cell metabolites
(2) fat granules
(3) ribosomes
(4) mitochondria.

2002

33. Which of the following statement is correct for node of Ranvier of nerve?
(1) Neurilemma is discontinuous.
(2) Myelin sheath is discontinuous.
(3) Both neurilemma and myelin sheath are discontinuous.
(4) Covered by myelin sheath.

2000

34. Depolarization of axolemma during nerve conduction takes place because of
(1) equal amount of Na^+ and K^+ move out across axolemma
(2) Na^+ move inside and K^+ move more outside
(3) more Na^+ outside
(4) none of these.

1999

35. Which cranial nerve has the highest number of branches?
(1) Vagus nerve
(2) Trigeminal nerve
(3) Facial nerve
(4) None of these

1999

36. Sympathetic nervous system induces
(1) secretion of digestive juices
(2) heart beat
(3) secretion of saliva
(4) all of these.

1999

37. The junction between the axon of one neuron and the dendrite of the next is called
(1) constant bridge
(2) junction point
(3) a joint
(4) a synapse.

1999

38. Which of the following is regarded as a unit of nervous tissue?
(1) Neurons
(2) Myelin sheath
(3) Axons
(4) Dendrites

1997

39. The vagus nerve is the cranial nerve numbering
(1) 7 (2) 5
(3) 10 (4) 9.

1997

40. The Nissl's granules of nerves cell are made up of
(1) DNA
(2) RNA
(3) ribosome
(4) protein.

NODIA

47. (1) X

The tenth cranial nerve, also known as the vagus nerve, is primarily responsible for the parasympathetic regulation of the heart. It sends inhibitory signals to the heart's pacemaker, which helps to slow down the heart rate during periods of rest. This control is vital for maintaining a healthy heart rhythm and ensuring that the cardiovascular system responds appropriately to the body's changing needs.

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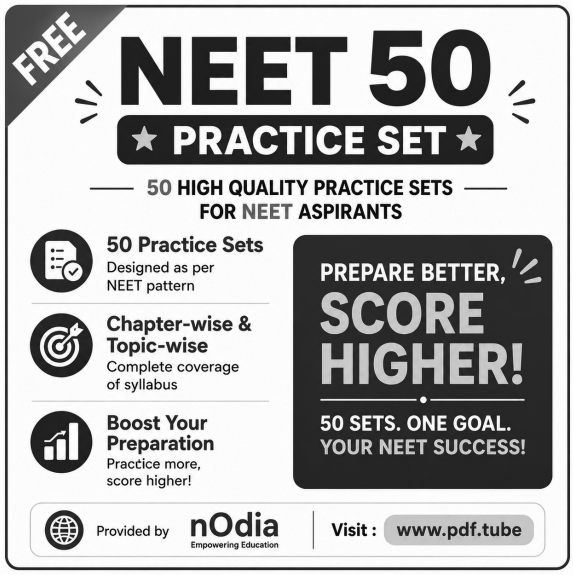

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ANSWERS

1. (2) Pericardium
The brain is protected by three meninges: outer dura mater, middle arachnoid, and inner pia mater. The pericardium is the double-membrane covering of the heart, not a part of the central neural system.

2. (4) Post-synaptic membrane
At a chemical synapse, neurotransmitters released from the pre-synaptic terminal diffuse across the synaptic cleft and bind to specific receptors located on the post-synaptic membrane. This binding opens ion channels, generating a new potential in the post-synaptic neuron and transmitting the impulse forward.

3. (1) A-III, B-I, C-IV, D-II
Schwann cells are responsible for forming the insulating myelin sheath around axons in the peripheral nervous system. The synaptic knob is a specialized structure containing vesicles that store and release neurotransmitters for signaling. Bipolar neurons, featuring one axon and one dendrite, are typically found in the retina. Multipolar neurons, characterized by several dendrites, are primarily located in the cerebral cortex.

4. (2) A-III, B-IV, C-II, D-I
The pons consists of fiber tracts that connect various regions of the brain to facilitate communication. The hypothalamus contains neurosecretory cells that produce vital hormones. The medulla oblongata regulates essential functions like respiration and gastric secretions. The cerebellum provides extra surface area for neurons, which is necessary for maintaining body posture and muscular balance during various physical activities and movements.

5. (3) Statement I is correct but Statement II is incorrect.
The corpus callosum is a large bundle of myelinated nerve fibers that connects the two cerebral hemispheres, allowing them to communicate. While the brain stem is a critical part of the central nervous system, it specifically consists of the midbrain, pons, and medulla oblongata. It does not include the cerebrum, which is actually a major part of the forebrain.

6. (1) Mid-brain, Pons and Medulla oblongata
The brainstem is a vital part of the central nervous system that connects the cerebrum and cerebellum to the spinal cord. It is composed of three main structures: the midbrain, the pons, and the medulla oblongata. These regions are responsible for regulating many basic life functions, including breathing, heart rate, and blood pressure, while also relaying sensory and motor signals.

7. (3) Limbic system & hypothalamus
Emotional responses and sexual behaviors are primarily regulated by the limbic system, which includes the amygdala and hippocampus. This system works in conjunction with the hypothalamus to manage complex states like pleasure, excitement, fear, and rage. Together, these structures integrate emotional experiences with autonomic functions and hormonal control, ensuring the body reacts appropriately to various internal and external emotional stimuli.

8. (4) Impulse transmission across a chemical synapse is always faster than that across an electrical synapse.
Electrical synapses allow for direct ion flow through gap junctions, enabling extremely rapid signal transmission. In contrast, chemical synapses rely on the release and binding of neurotransmitters, which introduces a brief delay. Therefore, transmission across electrical synapses is faster than across chemical ones. While chemical synapses are more common and allow for greater modulation, they are not faster than electrical connections.

9. (3) Hypothalamus
The hypothalamus functions as the primary center for thermoregulation in the human brain. It monitors the temperature of the blood and receives input from peripheral thermoreceptors in the skin. When body temperature deviates from the normal range, the hypothalamus initiates physiological responses, such as sweating or shivering, to restore balance. It also regulates

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2025

7. Which of the following hormones released from the pituitary is actually synthesized in the hypothalamus?
(1) Follicle-stimulating hormone (FSH)
(2) Adenocorticotrophic hormone (ACTH)
(3) Luteinizing hormone (LH)
(4) Anti-diuretic hormone (ADH)

2025

8. Match List-I with List-II.

List-I (Organs)		List-II (Hormones/Factors)	
A.	Heart	I.	Erythropoietin
B.	Kidney	II.	Aldosterone
C.	Gastro-intestinal tract	III.	Atrial natriuretic factor
D.	Adrenal Cortex	IV.	Secretin

Choose the correct answer from the options given below.
(1) A-I, B-III, C-IV, D-II
(2) A-III, B-I, C-IV, D-II
(3) A-II, B-I, C-III, D-IV
(4) A-IV, B-III, C-II, D-I

RE-EXAM 2024

9. Match List-I with List-II.

List-I (Hormones)		List-II (Functions)	
A.	Epinephrine	I.	Hyperglycemia
B.	Thyroxine	II.	Smooth muscle contraction
C.	Oxytocin	III.	Basal metabolic rate
D.	Glucagon	IV.	Emergency hormone

Choose the correct answer from the options given below.
(1) A-II, B-I, C-IV, D-III
(2) A-III, B-II, C-I, D-IV
(3) A-IV, B-III, C-II, D-I
(4) A-I, B-IV, C-III, D-II

2024

10. Match List I with List II.

List I (Disorders)		List II (Characteristics)	
A.	Exophthalmic goiter	I.	Excess secretion of cortisol, moon face and hyperglycemia
B.	Acromegaly	II.	Hypo-secretion of thyroid hormone and stunted growth.
C.	Cushing's syndrome	III.	Hyper secretion of thyroid hormone and protruding eye balls
D.	Cretinism	IV.	Excessive secretion of growth hormone

Choose the correct answer from the options given below.
(1) A-I, B-III, C-II, D-IV
(2) A-IV, B-II, C-I, D-III
(3) A-III, B-IV, C-II, D-I
(4) A-III, B-IV, C-I, D-II

RE-EXAM 2024

11. Identify the wrong statements.
A. Erythropoietin is produced by juxtaglomerular cells of the kidney.
B. Leydig cells produce androgens.
C. Atrial Natriuretic Factor, a peptide hormone is secreted by the seminiferous tubules of the tests.
D. Cholecystokinin is produced by gastrointestinal tract.
E. Gastrin acts on intestinal wall and helps in the production of pepsinogen.
Choose the most appropriate answer from the options given below.
(1) D and E only
(2) A and B only
(3) C and E only
(4) A and C only

NODIA

2024

12. Which of the following is not a steroid hormone?
(1) Cortisol (2) Testosterone
(3) Progesterone (4) Glucagon

Manipur NEET 2023

13. Given below are two statements :
Statement I : Parathyroid hormone acts on bones and stimulates the process of bone resorption.
Statement II : Parathyroid hormone along with Thyrocalcitonin plays a significant role in carbohydrate metabolism.
In the light of the above statements, choose the correct answer from the options given below :
(1) Statement I is correct but statement II is false.

ANSWERS

1. (4) α-cells of pancreas secrete insulin
In the islets of Langerhans, α-cells secrete glucagon and β-cells secrete insulin, not the reverse. So the statement that α-cells secrete insulin is incorrect. Glucagon does stimulate glycogenolysis, raising blood glucose.

2. (4) (a), (b) and (c) only
The pituitary is divided into adenohypophysis and neurohypophysis (a), secretes FSH (b) and MSH (c). It also secretes prolactin, so statement (d) is wrong. Hence the correct combination is (a), (b) and (c) only.

3. (4) A-III, B-IV, C-I, D-II
Excess growth hormone in adults causes acromegaly (III). Luteinising hormone induces ovulation (IV). Vasopressin (ADH) promotes reabsorption of water and electrolytes in the kidney (I). Oxytocin causes contraction of the uterus during childbirth (II).

4. (3) A-II, B-III, C-IV, D-I
Cortisol produces anti-inflammatory reactions. Aldosterone stimulates reabsorption of Na^+ and water from the renal tubule. Cholecystokinin stimulates secretion of pancreatic enzymes and bile juice. Progesterone stimulates the formation of alveoli in mammary glands, giving the match A-II, B-III, C-IV, D-I.

5. (3) A-IV, B-II, C-I, D-III
The corpus luteum secretes progesterone to maintain the uterine lining during pregnancy. Relaxin is produced by the ovary to facilitate childbirth by softening the pelvic ligaments. The pars intermedia of the pituitary gland produces melanocyte stimulating hormone, which affects skin pigmentation. Adrenal medulla secretes catecholamines like adrenaline and noradrenaline for emergency responses. These hormone matches are essential for understanding physiology.

6. (4) B, C and D Only
Adrenal medullary hormones, such as adrenaline and noradrenaline, prepare the body for emergency situations. These hormones are hyperglycemic because they stimulate glycogen breakdown into glucose. They also cause piloerection, which is the raising of hair, and increase the strength of heart contractions. However, they lead to pupillary dilation rather than constriction to improve vision during periods of acute stress.

7. (4) Anti-diuretic hormone (ADH)
Anti-diuretic hormone is synthesized by the supraoptic and paraventricular nuclei of the hypothalamus. It travels down the axons to the posterior pituitary gland, also known as the neurohypophysis, where it is stored and eventually released. This hormone plays a critical role in regulating water balance by increasing reabsorption in the distal tubules and collecting ducts of the human kidneys.

8. (2) A-III, B-I, C-IV, D-II
The heart secretes atrial natriuretic factor to reduce blood pressure, while the kidney produces erythropoietin to stimulate red blood cell formation. The gastrointestinal tract releases hormones like secretin to regulate digestion. Additionally, the adrenal cortex secretes aldosterone, which is essential for managing electrolyte and water balance. These specialized tissues perform vital endocrine functions alongside their primary physiological roles.

9. (3) A-IV, B-III, C-II, D-I
Epinephrine is an emergency hormone that prepares the body for stress, while thyroxine regulates the basal metabolic rate. Oxytocin is responsible for stimulating smooth muscle contractions during childbirth and milk ejection. Glucagon is a hyperglycemic hormone that increases blood glucose levels by promoting glycogenolysis. Each of these hormones performs specific regulatory functions across various organ systems to maintain homeostasis.

10. (4) A-III, B-IV, C-I, D-II
Exophthalmic goiter is caused by hypersecretion of thyroid hormone and is characterized by protruding eyeballs. Acromegaly results from excessive secretion of growth hormone in adults. Cushing's syndrome involves excess cortisol secretion, often causing a moon face and hyperglycemia. Cretinism occurs due

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2019

22. Match the following hormones with their respective disease.

	Hormones		Disease
(A)	Insulin	(i)	Addison's disease
(B)	Thyroxin	(ii)	Diabetes insipidus
(C)	Corticoids	(iii)	Acromegaly
(D)	Growth hormone	(iv)	Goitre
		(v)	Diabetes mellitus

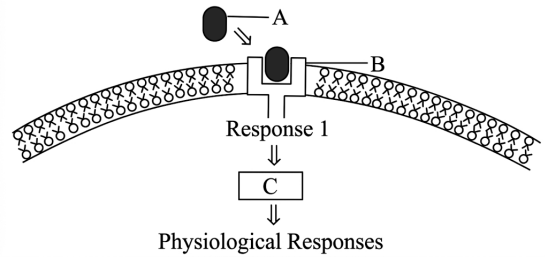
Select the correct option.
(1) (A)-(ii); (B)-(iv); (C)-(i); (D)-(iii)
(2) (A)-(v); (B)-(i); (C)-(ii); (D)-(iii)
(3) (A)-(ii); (B)-(iv); (C)-(iii); (D)-(i)
(4) (A)-(v); (B)-(iv); (C)-(i); (D)-(iii)

2019

23. How does steroid hormone influence the cellular activities?
(1) Using aquaporin channels 'as second messenger'
(2) Changing the permeability of the cell membrane
(3) Binding to DNA and forming a gene-hormone complex
(4) Activating cyclic AMP located on the cell membrane

Odisha NEET 2019

24. Identify A, B and C in the diagramatic representation of the mechanism of hormone action.
Select the correct option from the following.



(1) A-Steroid Hormone; B-Hormone-receptor Complex; C-Protein
(2) A-Protein Hormone; B-Receptor; C-Cyclic AMP
(3) A-Steroid Hormone; B-Receptor; C - Second Messenger
(4) A-Protein Hormone; B-Cyclic AMP; C-Hormone-receptor Complex

2018

25. Which of the following hormones can play a significant role in osteoporosis?
(1) Aldosterone and prolactin
(2) Progesterone and aldosterone
(3) Estrogen and parathyroid hormone
(4) Parathyroid hormone and prolactin

2018

26. Which of the following is an amino acid derived hormone?
(1) Epinephrine (2) Ecdysone
(3) Estradiol (4) Estriol

2017

27. GnRH, a hypothalamic hormone, needed in reproduction, acts on
(1) anterior pituitary gland and stimulates secretion of LH and FSH
(2) posterior pituitary gland and stimulates secretion of oxytocin and FSH
(3) posterior pituitary gland and stimulates secretion of LH and relaxin
(4) anterior pituitary gland and stimulates secretion of LH and oxytocin.

2017

28. Hypersecretion of growth hormone in adults does not cause further increase in height, because
(1) epiphyseal plates close after adolescence
(2) bones loose their sensitivity to growth hormone in adults
(3) muscle fibres do not grow in size after birth
(4) growth hormone becomes inactive in adults.

2017

29. A temporary endocrine gland in the human body is
(1) corpus cardiacum
(2) corpus luteum
(3) corpus allatum
(4) pineal gland.

NEET-II 2016

30. Graves' disease is caused due to
(1) hyposecretion of thyroid gland
(2) hypersecretion of thyroid gland
(3) hyposecretion of adrenal gland
(4) hypersecretion of adrenal gland.

NEET-II 2016

31. Name a peptide hormone which acts mainly on hepatocytes, adipocytes and enhances cellular glucose uptake and utilisation.
(1) Insulin (2) Glucagon
(3) Secretin (4) Gastrin

NODIA

Mains 2011

50. The 24 hour (diurnal) rhythm of our body such as the sleep-wake cycle is regulated by the hormone
(1) calcitonin
(2) prolactin
(3) adrenaline
(4) melatonin.

2011

51. Match the source gland with its respective hormone and function and select the correct option.
Source gland - Hormone - Function
(1) Anterior pituitary - Oxytocin - Contraction of uterus muscles during child birth
(2) Posterior pituitary - Vasopressin - Stimulates reabsorption of water in the distal tubules in the nephron
(3) Corpus luteum - Estrogen - Supports pregnancy
(4) Thyroid - Thyroxine - Regulates blood calcium level

2011

52. Given below is an incomplete table on hormones, their source glands and one major effect of each human body. Identify the option representing correct grouping of hormone its gland and effect.

Gland	**Secretion**	**Effect on body**
A	Estrogen	Maintenance of secondary sexual characters
Alpha cells of Islets of Langerhans	B	Raises blood sugar level
Anterior pituitary	C	Over secretion leads to gigantism

(1) A-Ovary; B-Glucagon; C-Growth hormone
(2) A-Placenta; B-Insulin; C-Vasopressin
(3) A-Ovary; B-Insulin; C-Calcitonin
(4) A-Placenta; B-Glucagon; C-Calcitonin

2010

53. Injury to adrenal cortex is not likely to affect the secretion of which one of the following?
(1) Aldosterone
(2) Both androstenedione and dehydroepiandrosterone
(3) Adrenaline
(4) Cortisol

2010

54. Which one of the following pairs is incorrectly matched?
(1) Glucagon – Beta cells (source)
(2) Somatostatin – Delta cells (source)
(3) Corpus luteum – Relaxin (secretion)
(4) Insulin – Diabetes mellitus (disease)

2010

55. Toxic agents present in food which interfere with thyroxine synthesis lead to the development of
(1) toxic goitre (2) cretinism
(3) simple goitre (4) thyrotoxicosis.

2010

56. Select the correct matching of a hormone, its source and function.

	Hormone	**Source**	**Function**
(1)	Vasopressin	Posterior pituitary	Increases loss of water through urine
(2)	Norepinephrine	Adrenal medulla	Increases heart beat, rate of respiration and alterness
(3)	Glucagon	Beta-cells of Islets of Langerhans	Stimulates glycogenolysis
(4)	Prolactin	Posterior pituitary	Regulates growth of mammary glands and milk formation in females

2009

57. A health disorder that results from the deficiency of thyroxine in adults and characterised by
(i) a low metabolic rate.
(ii) increase in body weight.
(iii) tendency to retain water in tissues is
(1) simple goitre
(2) myxoedema
(3) cretinism
(4) hypothyroidism.

2008

58. Which one of the following pair of organs includes only the endocrine glands?
(1) Thymus and testes
(2) Adrenal and ovary
(3) Parathyroid and adrenal
(4) Pancreas and parathyroid

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(3)	Leydig's cells	Androgen	Initiates the production of sperms
(4)	Ovary	FSH	Stimulates follicular development and the secretion of estrogens

Karnataka NEET 2013

42. Nor-epinephrine
(i) is released by sympathetic fibers
(ii) is released by parasympathetic fibers
(iii) increases the heart rate
(iv) decreases blood pressure.
Which of the above statements are correct?
(1) (i) and (iii) (2) (ii) and (iii)
(3) (ii) and (iv) (4) (i) and (iv)

Karnataka NEET 2013

43. Which of the following represents the action of insulin?
(1) Increases blood glucose level by stimulating glucagon production.
(2) Decreases blood glucose levels by forming glycogen.
(3) Increases blood glucose levels by promoting cellular uptake of glucose.
(4) Increases blood glucose levels by hydrolysis of glycogen.

2013

44. Which of the following statements is correct in relation to the endocrine system?
(1) Non-nutrient chemicals produced by the body in trace amounts that act as intercellular messenger are known as hormones.
(2) Releasing and inhibitory hormones are produced by the pituitary gland.
(3) Adenohypophysis is under direct neural regulation of the hypothalamus.
(4) Organs in the body like gastrointestinal tract, heart, kidney and liver do not produce any hormones.

Karnataka NEET 2013

45. Which of the following best illustrates "feedback" in development?
(1) Tissue X secretes RNA which changes the development of tissue Y.
(2) As tissue X develops, it secretes enzymes that inhibit the development of tissue Y.
(3) As tissue X develops, it secretes something that induces tissue Y to develop.
(4) As tissue X develops, it secretes something that slows down the growth of tissue Y.

2012

46. A person entering an empty room suddenly finds a snake right in front on opening the door. Which one of the following is likely to happen in his neuro-hormonal control system?
(1) Sympathetic nervous system is activated releasing epinephrine and norepinephrine from adrenal medulla.
(2) Neurotransmitters diffuse rapidly across the cleft and transmit a nerve impulse.
(3) Hypothalamus activates the parasympathetic division of brain.
(4) Sympathetic nervous system is activated releasing epinephrine and norepinephrine from adrenal cortex.

2012

47. Which one of the following pairs of hormones are the examples of those that can easily pass through the cell membrane of the target cell and bind to a receptor inside it (mostly in the nucleus)?
(1) Insulin, glucagon
(2) Thyroxine, insulin
(3) Somatostatin, oxytocin
(4) Cortisol, testosterone

2012

48. What is correct to say about the hormone action in humans?
(1) Glucagon is secreted by β-cells of islets of Langerhans and stimulates glycogenolysis.
(2) Secretion of thymosins is stimulated with aging.
(3) In females, FSH first binds with specific receptors on ovarian cell membrane.
(4) FSH stimulates the secretion of estrogen and progesterone.

2012

49. Which one of the following pairs of chemical substances, is correctly categorised?
(1) Calcitonin and thymosin - Thyroid hormones
(2) Pepsin and prolactin - Two digestive enzymes secreted in stomach
(3) Troponin and myosin - Complex proteins in striated muscles
(4) Secretin and rhodopsin - Polypeptide hormones

NODIA

(2) Statement I is incorrect but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

Manipur NEET 2023

14. Which of the following statements are correct with respect to the hormone and its function?
A. Thyrocalcitonin (TCT) regulates the blood calcium level.
B. In males, FSH and androgens regulate spermatogenesis.
C. Hyperthyroidism can lead to goitre.
D. Glucocorticoids are secreted in adrenal medulla.
E. Parathyroid hormone is regulated by circulating levels of sodium ions.
Choose the most appropriate answer from the options given below.
(1) (C) and (E) only
(2) (A) and (B) only
(3) (B) and (C) only
(4) (A) and (D) only

2023

15. Which of the following are not under the control of thyroid hormone?
A. Maintenance of water and electrolyte balance
B. Regulation of basal metabolic rate
C. Normal rhythm of sleep-wake cycle
D. Development of immune system
E. Support the process of RBCs formation
Choose the correct answer from the options given below.
(1) C and D only (2) D and E only
(3) A and D only (4) B and C only

2023

16. Match List I with List II.

List I (Hormones)		List II (Target/Associated Organ)	
A.	CCK	I.	Kidney
B.	CCK	II.	Heart
C.	ANF	III.	Gastric gland
D.	ADH	IV.	Pancreas

Choose the correct answer from the options given below.
(1) A-II, B-IV, C-I, D-III
(2) A-IV, B-II, C-III, D-I
(3) A-IV, B-III, C-II, D-I
(4) A-III, B-II, C-IV, D-I

2022

17. Which of the following are not the effects of parathyroid hormone ?
A. Stimulates the process of bone resorption
B. Decreases Ca^{2+} level in blood
C. Reabsorption of Ca^{2+} by renal tubules
D. Decreases the absorption of Ca^{2+} from digested food
E. Increases metabolism of carbohydrates
Choose the most appropriate answer from the options given below.
(1) (A) and (C) only
(2) (B), (D) and (E) only
(3) (A) and (E) only
(4) (B) and (C) only

2021

18. Erythropoietin hormone which stimulates RBC formation is produced by
(1) juxtaglomerular cells of the kidney
(2) alpha cells of pancreas
(3) the cells of rostral adenohypophysis
(4) the cells of bone marrow.

2020

19. Presence of which of the following conditions in urine are indicative of diabetes mellitus?
(1) Uremia and Ketonuria
(2) Uremia and Renal Calculi
(3) Ketonuria and Glycosuria
(4) Renal calculi and Hyperglycaemia

2020

20. Match the following columns and select the correct option.

Column-I (Glands)		Column-II (Diseases)	
(A)	Pituitary gland	(i)	Grave's disease
(B)	Thyroid gland	(ii)	Diabetes mellitus
(C)	Adrenal gland	(iii)	Diabetes insipidus
(D)	Pancreas	(iv)	Addison's disease

(1) (A)-(iv); (B)-(iii); (C)-(i); (D)-(ii)
(2) (A)-(iii); (B)-(ii); (C)-(i); (D)-(iv)
(3) (A)-(iii); (B)-(i); (C)-(iv); (D)-(ii)
(4) (A)-(ii); (B)-(i); (C)-(iv); (D)-(iii)

2020

21. Select the correct statement.
(1) Glucocorticoids stimulate gluconeogenesis.
(2) Glucagon is associated with hypoglycemia.
(3) Insulin acts on pancreatic cells and adipocytes.
(4) Insulin is associated with hyperglycemia.

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2008

59. The blood calcium level is lowered by the deficiency of
(1) both calcitonin and parathormone
(2) calcitonin
(3) parathormone
(4) thyroxine.

2007

60. Feeling the tremors of an earthquake a scared resident of seventh floor of a multistoryed building starts climbing down the stairs rapidly. Which hormone initiated this action?
(1) Adrenaline
(2) Glucagon
(3) Gastrin
(4) Thyroxine

2007

61. A person is having problems with calcium and phosphorus metabolism in his body. Which one of the following glands may not be functioning properly?
(1) Parotid
(2) Pancreas
(3) Thyroid
(4) Parathyroid

2006

62. Which one of the following statements is correct?
(1) Endocrine glands regulate neural activity, but not vice versa.
(2) Neurons regulate endocrine activity, but not vice versa.
(3) Endocrine glands regulate neural activity and nervous system regulates endocrine glands.
(4) Neither hormones control neural activity nor the neurons control endocrine activity.

2006

63. Which hormone causes dilation of blood vessels, increased oxygen consumption and glucogenesis?
(1) Glucagon
(2) ACTH
(3) Insulin
(4) Adrenaline

2006

64. Which of the following is an accumulation and release centre of neurohormones?
(1) Anterior pituitary lobe
(2) Posterior pituitary lobe
(3) Intermediate lobe of the pituitary
(4) Hypothalamus

2006

65. A steroid hormone which regulates glucose metabolism is
(1) cortisone
(2) cortisol
(3) corticosterone
(4) 11-deoxycorticosterone.

2006

66. Which one of the following is not a secondary messenger in hormone action?
(1) cAMP
(2) cGMP
(3) Calcium
(4) Sodium

2004

67. Which one of the following pairs correctly matches a hormone with a disease resulting from its deficiency?
(1) Luteinising hormone - Failure of ovulation
(2) Insulin - Diabetes insipidus
(3) Thyroxine - Tetany
(4) Parathyroid hormone - Diabetes mellitus

2004

68. Which one of the following hormones is modified amino acid?
(1) Epinephrine
(2) Progesterone
(3) Prostaglandin
(4) Estrogen

2004

69. Chemically hormones are
(1) biogenic amines only
(2) proteins, steroids and biogenic amines
(3) proteins only
(4) steroids only.

2003

70. Which one of the following pairs correctly matches a hormone with a disease resulting from its deficiency ?
(1) Relaxin – Gigantism
(2) Prolactin – Cretinism
(3) Parathyroid hormone – Tetany
(4) Insulin – Diabetes insipidus

2002

71. Acromegaly is caused by
(1) excess of STH
(2) excess of thyroxine
(3) deficiency of thyroxine
(4) excess of adrenaline.

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NEET-II 2016

32. The posterior pituitary gland is not a 'true' endocrine gland because
(1) it is provided with a duct
(2) it only stores and releases hormones
(3) it is under the regulation of hypothalamus
(4) it secretes enzymes.

NEET-I 2016

33. Which of the following pairs of hormones are not antagonistic (having opposite effects) to each other?
(1) Aldosterone - Atrial Natriuretic Factor
(2) Relaxin - Inhibin
(3) Parathormone - Calcitonin
(4) Insulin - Glucagon

NEET-I 2016

34. The amino acid tryptophan is the precursor for the synthesis of
(1) estrogen and progesterone
(2) cortisol and cortisone
(3) melatonin and serotonin
(4) thyroxine and triiodothyronine.

2015

35. Which one of the following hormones is not involved in sugar metabolism?
(1) Insulin (2) Glucagon
(3) Cortisone (4) Aldosterone

2015

36. Which one of the following hormones though synthesised elsewhere, is stored and released by the master gland?
(1) Prolactin
(2) Melanocyte stimulating hormone
(3) Antidiuretic hormone
(4) Luteinising hormone

2014

37. Fight-or-flight reactions cause activation of
(1) the parathyroid glands, leading to increased metabolic rate
(2) the kidney, leading to suppression of renin-angiotensin-aldosterone pathway
(3) the adrenal medulla, leading to increased secretion of epinephrine and norepinephrine
(4) the pancreas leading to a reduction in the blood sugar levels.

2014

38. Identify the hormone with its correct matching of source and function.
(1) Oxytocin - posterior pituitary, growth and maintenance of mammary glands.
(2) Melatonin - pineal gland, regulates the normal rhythm of sleepwake cycle.
(3) Progesterone - corpus luteum, stimulation of growth and activities of female secondary sex organs.
(4) Atrial natriuretic factor - ventricular wall, increases the blood pressure.

2013

39. A pregnant female delivers a baby who suffers from stunted growth, mental retardation, low intelligence quotient and abnormal skin. This is the result of
(1) cancer of the thyroid gland
(2) oversecretion of pars distalis
(3) deficiency of iodine in diet
(4) low secretion of growth hormone.

NEET 2013

40. Select the answer which correctly matches the endocrine gland with the hormone it secretes and its function/deficiency symptom.

	Endocrine gland	**Hormone**	**Function/ Deficiency symptoms**
(1)	Thyroid gland	Thyroxine	Lack of iodine in diet results in goitre
(2)	Corpus luteum	Testosterone	Stimulates spermatogenesis
(3)	Anterior pituitary	Oxytocin	Stimulates uterus contraction during child birth
(4)	Posterior pituitary	Growth hormone (GH)	Oversecretion stimulates abnormal growth

Karnataka NEET 2013

41. Select the option which correctly matches the endocrine gland with its hormone and its function.

	Endocrine gland	**Hormone**	**Function**
(1)	Placenta	Estrogen	Initiates secretion of the milk
(2)	Corpus luteum	Estrogen	Essential for maintenance of endometrium

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1998

87. The contraction of gall bladder is due to
(1) cholecystokinin
(2) enterogastrone
(3) gastrin
(4) secretin.

1997

88. Hormones thyroxine, adrenaline and the pigment melanin are formed from
(1) tyrosine (2) proline
(3) tryptophan (4) glycine.

1996

89. Which hormone stimulates the secretion of milk from female?
(1) Oxytocin
(2) Progesterone
(3) LH
(4) Prolactin

1995

90. Which one of the following endocrine glands stores its secretion in the extracellular space before discharging it into the blood?
(1) Testis
(2) Thyroid
(3) Pancreas
(4) Adrenal

1995

91. According to the accepted concept of hormone action, if receptor molecules are removed from target organs, then the target organ will
(1) continue to respond to the hormone without any difference
(2) not respond to the hormone
(3) continue to respond to the hormone but will require higher concentration
(4) continue to respond to the hormone but in the opposite way.

1994

92. The immediate cause of induction of ovulation in human female is the large plasma surge of
(1) LH
(2) FSH
(3) progesterone
(4) estradiol.

1993

93. Testosterone is produced by
(1) sertoli cells
(2) Leydig's cells
(3) oxyntic cells
(4) pituitary gland.

1993

94. Gastric secretion is stopped by hormone
(1) enterogastrone
(2) gastrin
(3) pancreozymin
(4) cholecystokinin.

1991

95. ADH or vasopressin is
(1) enzyme that hydrolyses peptides
(2) hormone secreted by pituitary that promotes reabsorption of water from glomerular filtrate
(3) hormone that promotes glycogenolysis
(4) energy rich compound connected with muscle contraction.

1991

96. Occurrence of Leydig's cells and their secretion is
(1) ovary and estrogen
(2) liver and cholesterol
(3) pancreas and glucagon
(4) testis and testosterone.

1990

97. Insulin is a
(1) vitamin
(2) lipid
(3) hormone
(4) enzyme.

1988

98. Which hormone possesses anti-insulin effect?
(1) Cortisol
(2) Calcitonin
(3) Oxytocin
(4) Aldosterone

1988

99. MSH of pars intermedia of middle pituitary is responsible for
(1) darkening of skin in lower vertebrates
(2) light colouration of skin in lower vertebrates
(3) both A and B
(4) darkening of skin in human beings.

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2002

72. Adrenaline directly affects on
(1) SA node
(2) β-cells of Langerhans
(3) dorsal root of spinal nerve
(4) epithelial cells of stomach.

2002

73. When both ovaries are removed from rat then which hormone is decreased in blood?
(1) Oxytocin
(2) Prolactin
(3) Estrogen
(4) Gonadotropin releasing factor

2002

74. Mainly which type of hormones control the menstrual cycle in human beings?
(1) FSH
(2) LH
(3) FSH, LH, estrogen
(4) progesterone

2001

75. Which set is similar?
(1) Corpus luteum - Graafian follicles
(2) Sebum - Sweat
(3) Bundle of His - Pace maker
(4) Vitamin B_7 - Niacin

2000

76. Melatonin is secreted by
(1) pineal body
(2) skin
(3) pituitary gland
(4) thyroid.

2000

77. Which gland secretes odorous secretion in mammals?
(1) Bartholins
(2) Prostate
(3) Anal gland
(4) Liver

2000

78. MSH is secreted by
(1) anterior lobe of pituitary
(2) middle lobe of pituitary
(3) posterior lobe of pituitary
(4) endostyle.

1999

79. The function of oxytocin is to help in
(1) child birth
(2) gametogenesis
(3) growth
(4) lactation.

1999

80. Secretion of progesterone by corpus luteum is initiated by
(1) testosterone
(2) thyroxine
(3) MSH
(4) LH.

1999

81. The gonadotrophic hormones are secreted by
(1) anterior lobe of pituitary
(2) interstitial cells of testes
(3) adrenal cortex
(4) posterior part of thyroid.

1999

82. Diabetes is due to
(1) enzyme deficiency
(2) iodine deficiency
(3) Na^+ deficiency
(4) hormonal deficiency.

1999

83. Cholecystokinin and duocrinin are secreted by
(1) adrenal cortex
(2) thyroid gland
(3) intestine
(4) pancreas.

1998

84. Calcitonin is a thyroid hormone which
(1) elevates calcium level in blood
(2) has no effect on calcium
(3) elevates potassium level in blood
(4) lowers calcium level in blood.

1998

85. The hormone which regulates the basal metabolism in our body is secreted from
(1) adrenal cortex
(2) pancreas
(3) pituitary
(4) thyroid.

1998

86. The hormone that stimulates the stomach to secrete gastric juice is
(1) enterokinase
(2) enterogastrone
(3) gastrin
(4) renin.

NODIA

to hyposecretion of thyroid hormone during development, leading to stunted growth. These clinical conditions highlight the impacts of hormonal imbalances.

11. (3) C and E only
Atrial Natriuretic Factor is a peptide hormone secreted by the atrial walls of the heart to lower blood pressure, rather than the seminiferous tubules. Gastrin is produced by the stomach and acts on gastric glands to stimulate the secretion of hydrochloric acid and pepsinogen. Since the original statements in the question are physiologically inaccurate, both represent incorrect information regarding hormonal sources.

12. (4) Glucagon
Cortisol, testosterone, and progesterone are steroid hormones derived from cholesterol. They are lipid-soluble and can pass through cell membranes to bind with intracellular receptors. Glucagon, however, is a peptide hormone composed of amino acids. It acts on the surface of target cells through a second messenger system. Therefore, among the choices provided, only glucagon does not belong to the steroid class.

13. (1) Statement I is correct but statement II is false.
Parathyroid hormone acts directly on the bones to stimulate the process of bone resorption, which increases the concentration of calcium ions in the blood. While thyrocalcitonin and parathyroid hormone are critical for regulating calcium levels in the body, they do not play a significant role in carbohydrate metabolism. Therefore, the first claim is physiologically accurate, while the second claim is false.

14. (2) (A) and (B) only
Thyrocalcitonin is a hormone secreted by the thyroid gland that helps regulate blood calcium levels by lowering them. In males, follicle-stimulating hormone and androgens are essential regulators of spermatogenesis. Hyperthyroidism typically results in Grave's disease, while glucocorticoids are secreted by the adrenal cortex. Furthermore, parathyroid hormone levels are primarily regulated by the circulating concentration of calcium ions in the blood.

15. (1) C and D only
Thyroid hormones are essential for regulating the basal metabolic rate, maintaining water and electrolyte balance, and supporting the process of red blood cell formation. However, they are not primarily responsible for controlling the normal rhythm of the sleep-wake cycle, which is regulated by melatonin. Additionally, the development and maturation of the immune system is mainly under the control of thymosin.

16. (3) A-IV, B-III, C-II, D-I
Cholecystokinin is secreted by the small intestine and acts on the pancreas to stimulate enzyme release. Gastric inhibitory peptide targets gastric glands to inhibit secretion. Atrial natriuretic factor is produced by the heart to lower blood pressure. Anti-diuretic hormone acts on the kidney tubules to facilitate water reabsorption. These hormones illustrate the diverse endocrine communications between various organs and tissues.

17. (2) (B), (D) and (E) only
Parathyroid hormone increases blood calcium levels by stimulating bone resorption and enhancing calcium reabsorption in the renal tubules. It also promotes the absorption of calcium from digested food in the intestine. However, it does not decrease calcium levels, nor does it reduce calcium absorption from food or increase carbohydrate metabolism. These specific functions are instead related to other hormones like thyrocalcitonin.

18. (1) juxtaglomerular cells of the kidney
Erythropoietin is a specialized peptide hormone primarily produced by the juxtaglomerular cells of the kidney. Its main function is to stimulate erythropoiesis, which is the process of red blood cell production in the bone marrow. This hormone is released in response to low oxygen levels in the blood, ensuring that the body maintains an adequate supply of oxygen-carrying cells.

19. (3) Ketonuria and Glycosuria
Diabetes mellitus is characterized by hyperglycemia, where blood glucose levels exceed the renal threshold. This results in glycosuria, the excretion of glucose in the urine. Additionally, the body begins breaking down fats for energy, producing ketone bodies that are excreted through the urine, a condition known as ketonuria. Both symptoms are significant clinical

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the blood. While other hormones like oxytocin or gonadotropins are involved in reproduction, they are produced by the pituitary or hypothalamus. Therefore, estrogen is the hormone most affected.

74. (3) FSH, LH, estrogen
The menstrual cycle is complexly regulated by a combination of hormones from the pituitary and the ovaries. Follicle-stimulating hormone and luteinizing hormone from the anterior pituitary stimulate the development of follicles and trigger ovulation. Estrogen, produced by the growing follicles, helps rebuild the uterine lining. The coordinated fluctuations of these three hormones are essential for the successful progression of cycle phases.

75. (1) Corpus luteum - Graafian follicles
The corpus luteum and the Graafian follicle are both stages in the development of the same structure within the ovary. The Graafian follicle contains the maturing egg, and after ovulation occurs, the remains of this follicle transform into the corpus luteum. The corpus luteum then functions as a temporary endocrine gland. This relationship makes them a similar set in reproduction.

76. (1) pineal body
Melatonin is a hormone primarily secreted by the pineal gland, which is located in the brain. Its production is influenced by light and darkness, with levels typically rising during the night. Melatonin is essential for regulating the body's internal clock and the circadian rhythm, particularly the sleep-wake cycle. While it affects skin pigmentation in lower vertebrates, its main human role relates.

77. (3) Anal gland
Many mammals possess specialized glands that produce odorous secretions used for communication or territory marking. The anal gland is a well-known example, secreting substances with a strong and distinctive scent. These secretions can convey information about the individual's identity or reproductive status. While other glands produce secretions, the anal gland is specifically associated with odorous territorial marking in various species.

78. (2) middle lobe of pituitary
Melanocyte-stimulating hormone is secreted by the middle lobe of the pituitary gland, which is also known as the pars intermedia. This hormone is responsible for the distribution of melanin pigments in the skin of many animals. In humans, the pars intermedia is often reduced or merged with the anterior lobe, but the hormone's classical source remains the middle lobe of pituitary.

79. (1) child birth
Oxytocin is a hormone produced by the hypothalamus and released by the posterior pituitary. It plays a critical role during child birth by stimulating powerful contractions of the smooth muscles in the uterine wall. These contractions help push the fetus through the birth canal. Additionally, oxytocin facilitates milk ejection from the mammary glands. Therefore, its primary function is assisting labor.

80. (4) LH.
After ovulation, the ruptured Graafian follicle is converted into the corpus luteum under the influence of luteinizing hormone. This pituitary hormone is essential for initiating and maintaining the secretion of progesterone from the corpus luteum. Progesterone then works to prepare and maintain the uterine lining for a possible pregnancy. Without the continued stimulus of LH, the corpus luteum would degenerate.

81. (1) anterior lobe of pituitary
The gonadotrophic hormones, which include follicle-stimulating hormone and luteinizing hormone, are secreted by the anterior lobe of the pituitary gland. These hormones are essential for the proper functioning of the gonads, namely the testes in males and the ovaries in females. They regulate the production of gametes and the secretion of sex hormones. Their release is controlled by the hypothalamus.

82. (4) hormonal deficiency.
Diabetes is a medical condition primarily resulting from a hormonal deficiency. Diabetes mellitus is caused by a lack of insulin, leading to high blood sugar. Diabetes insipidus, on the other hand, is caused by a deficiency of anti-diuretic hormone, resulting in excessive thirst and urination. Both types demonstrate how the absence of specific hormones can disrupt homeostasis and health in humans.

NODIA

adolescence, preventing any further increase in height. Even if growth hormone is hypersecreted in adulthood, only the bones of the hands, feet, and face may thicken, leading to a condition called acromegaly.

29. (2) corpus luteum
The corpus luteum is a temporary endocrine structure formed in the ovary after ovulation. It develops from the remains of the Graafian follicle and primarily secretes progesterone to prepare the uterus for potential pregnancy. If fertilization does not occur, the corpus luteum degenerates. Unlike permanent glands like the pineal or pituitary, its existence is transient and dependent on the menstrual cycle.

30. (2) hypersecretion of thyroid gland
Graves' disease is an autoimmune disorder that leads to hyperthyroidism, which is the overproduction of thyroid hormones. This condition increases the basal metabolic rate and is often characterized by symptoms such as weight loss, rapid heartbeat, and protruding eyeballs, known as exophthalmos. It is a common cause of thyroid enlargement and requires clinical management to regulate the excessive hormonal activity.

31. (1) Insulin
Insulin is a peptide hormone produced by the beta cells of the pancreas. Its primary function is to regulate blood glucose levels by acting on hepatocytes and adipocytes. It enhances the uptake and utilization of glucose by these cells and promotes the conversion of glucose into glycogen. This action effectively lowers blood sugar levels, making insulin critical for maintaining glucose homeostasis.

32. (2) it only stores and releases hormones
The posterior pituitary gland, or neurohypophysis, is not considered a true endocrine gland because it does not synthesize its own hormones. Instead, it serves as a storage and release site for oxytocin and vasopressin, which are produced by neurons in the hypothalamus. These hormones are transported down axons to the posterior pituitary, where they are held until needed by the body.

33. (2) Relaxin - Inhibin
Antagonistic hormones have opposite physiological effects on the body. For instance, insulin lowers blood glucose while glucagon raises it, and parathormone increases blood calcium while calcitonin decreases it. Aldosterone and atrial natriuretic factor also have opposing roles in blood pressure regulation. However, relaxin and inhibin are not antagonistic; relaxin facilitates childbirth, while inhibin inhibits follicle-stimulating hormone secretion during cycles.

34. (3) melatonin and serotonin
Tryptophan is an essential amino acid that serves as the biochemical precursor for the synthesis of several important molecules. In the pineal gland, tryptophan is converted into serotonin, which is subsequently transformed into melatonin. Melatonin is crucial for regulating the sleep-wake cycle and circadian rhythms. Therefore, these two compounds are the primary hormonal products derived from tryptophan metabolism within the body.

35. (4) Aldosterone
Aldosterone is a mineralocorticoid secreted by the adrenal cortex that primarily regulates the balance of water and electrolytes, such as sodium and potassium. In contrast, insulin, glucagon, and cortisone are directly involved in sugar metabolism by regulating blood glucose levels or stimulating gluconeogenesis. Aldosterone does not participate in the physiological processes associated with glucose or glycogen regulation in human cells.

36. (3) Antidiuretic hormone
Anti-diuretic hormone, also known as vasopressin, is synthesized by neurons in the hypothalamus. After production, it is transported down axons to the posterior pituitary gland, which is part of the master gland system. The posterior pituitary stores and later releases this hormone into the bloodstream to regulate water balance. Although the pituitary releases it, the actual synthesis occurs outside the gland.

37. (3) the adrenal medulla, leading to increased secretion of epinephrine and norepinephrine
The fight-or-flight response is an acute stress reaction mediated by the sympathetic nervous system. This response triggers the adrenal medulla to rapidly secrete large amounts of epinephrine and norepinephrine into the bloodstream. These catecholamines increase the heart rate, raise blood pressure, and elevate blood glucose levels

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indicators used to diagnose this metabolic disease.

20. (3) (iii) (i) (iv) (ii)
Diabetes insipidus is associated with the pituitary gland due to deficient anti-diuretic hormone, while Grave's disease results from thyroid hyperactivity. Addison's disease is caused by the underproduction of hormones from the adrenal gland. Diabetes mellitus is a metabolic disorder linked to pancreatic dysfunction. Each condition demonstrates how the malfunctioning of a specific endocrine gland leads to characteristic clinical symptoms and physiological imbalances.

21. (1) Glucocorticoids stimulate gluconeogenesis.
Glucocorticoids, such as cortisol, stimulate gluconeogenesis to increase blood sugar levels. Glucagon is a hyperglycemic hormone that raises blood glucose, whereas insulin is hypoglycemic and lowers it. Insulin primarily acts on hepatocytes and adipocytes to enhance glucose uptake and utilization. Therefore, the statement regarding glucocorticoids and gluconeogenesis accurately describes their role in metabolism, while the other statements contain physiological inaccuracies.

22. (4) (v) (iv) (i) (iii)
Diabetes mellitus is caused by insulin deficiency, while goitre results from thyroxine imbalance. Addison's disease is linked to the hyposecretion of corticoids from the adrenal gland. Acromegaly is the result of excessive growth hormone secretion in adults. Each of these diseases arises from the abnormal functioning of a specific endocrine gland, leading to significant physiological disruptions that require medical diagnosis.

23. (3) Binding to DNA and forming a gene-hormone complex
Steroid hormones are lipid-soluble molecules that can easily diffuse through the cell membrane of target cells. Once inside, they move into the nucleus and bind to specific intracellular receptors. This binding creates a hormone-receptor complex that interacts directly with DNA to regulate gene expression. By forming this complex, steroid hormones influence the synthesis of specific proteins, thereby altering cellular activities.

24. (2) A-Protein Hormone; B-Receptor; C-Cyclic AMP
In the mechanism of protein hormone action, the hormone acts as the primary messenger and binds to a specific receptor on the cell membrane. This binding triggers the production of a second messenger, such as cyclic AMP, inside the cell. The second messenger then initiates a cascade of biochemical responses. This process allows the hormone to influence activities without entering the cell.

25. (3) Estrogen and parathyroid hormone
Osteoporosis is a condition characterized by reduced bone density and an increased risk of fractures. Estrogen plays a vital role in maintaining bone mass, and its deficiency, especially after menopause, leads to bone loss. Parathyroid hormone regulates calcium levels and can stimulate bone resorption. Therefore, imbalances in these two hormones significantly contribute to the development and progression of osteoporosis in humans.

26. (1) Epinephrine
Epinephrine is an amino acid derived hormone synthesized from tyrosine in the adrenal medulla. It is part of the catecholamine group and functions as a primary mediator of the fight-or-flight response. In contrast, ecdysone, estradiol, and estriol are steroid hormones derived from cholesterol. Understanding the chemical nature of hormones is essential for comprehending their synthesis, transport, and mechanisms of hormonal action.

27. (1) anterior pituitary gland and stimulates secretion of LH and FSH
Gonadotropin-releasing hormone is a hypothalamic hormone that travels through the portal circulatory system to the anterior pituitary gland. Upon reaching its target, it stimulates the secretion of two gonadotropins: luteinizing hormone and follicle-stimulating hormone. These hormones are essential for the regulation of reproductive processes in both males and females. The coordination between the hypothalamus and anterior pituitary is vital.

28. (1) epiphyseal plates close after adolescence
Growth hormone stimulates the lengthening of long bones by acting on the epiphyseal plates located at the ends of the bones. In adults, these plates undergo ossification and close after

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46. (1) Sympathetic nervous system is activated releasing epinephrine and norepinephrine from adrenal medulla.
Encountering a sudden threat activates the body's sympathetic nervous system as part of the fight-or-flight response. This activation causes the adrenal medulla to release the hormones epinephrine and norepinephrine. These catecholamines increase heart rate, blood pressure, and alertness to prepare the person for immediate action. The adrenal medulla is the specific tissue responsible for this hormonal surge during acute stress.

47. (4) Cortisol, testosterone
Steroid hormones, such as cortisol and testosterone, are lipid-soluble and can easily pass through the phospholipid bilayer of the target cell membrane. Once inside the cytoplasm, they move into the nucleus to bind with specific intracellular receptors. This hormone-receptor complex interacts with DNA to regulate gene expression and protein synthesis. These characteristics distinguish them from peptide hormones, which bind to membrane receptors.

48. (3) In females, FSH first binds with specific receptors on ovarian cell membrane.
In the female reproductive system, follicle-stimulating hormone is a peptide hormone that travels through the blood to the ovaries. Because it cannot cross the cell membrane, it binds to specific receptors located on the ovarian cell membrane. This binding activates a second messenger system to initiate follicular development. Unlike steroid hormones, FSH and other peptide hormones rely on membrane-bound receptors.

49. (3) Troponin and myosin - Complex proteins in striated muscles
Troponin and myosin are both complex proteins found in striated muscle fibers and are essential for the mechanism of muscle contraction. Troponin regulates the interaction between actin and myosin in the presence of calcium ions. While calcitonin is a thyroid hormone, thymosin is produced by the thymus. Prolactin is a hormone, but pepsin is a digestive enzyme. Therefore, these muscle proteins are correctly identified.

50. (4) melatonin.
Melatonin is a hormone produced and secreted by the pineal gland in response to darkness. It plays a central role in regulating the 24-hour diurnal rhythm of the body, particularly the sleep-wake cycle. By signaling the body to prepare for rest, melatonin helps synchronize internal biological processes with the external environment. Other hormones like adrenaline or prolactin have entirely different physiological functions.

51. (2) Posterior pituitary - Vasopressin - Stimulates reabsorption of water in the distal tubules in the nephron
The posterior pituitary gland stores and releases vasopressin, also known as anti-diuretic hormone, which is synthesized in the hypothalamus. Vasopressin acts on the distal convoluted tubules and collecting ducts of the nephron to stimulate the reabsorption of water. This process helps the body conserve water and regulate blood pressure. Other pairings are incorrect as oxytocin is from the posterior pituitary.

52. (1) Ovary - Glucagon - Growth hormone
The ovaries are the primary source of estrogen, which maintains female secondary sexual characters. Alpha cells of the Islets of Langerhans secrete glucagon to raise blood sugar levels by stimulating glycogenolysis. The anterior pituitary gland produces growth hormone, and its over-secretion during childhood leads to gigantism. These hormones and their respective glands are fundamental components of the human endocrine regulatory system.

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53. (3) Adrenaline
The adrenal gland is divided into the cortex and the medulla. The cortex secretes hormones like aldosterone, cortisol, and various androgens. In contrast, the adrenal medulla produces catecholamines, such as adrenaline and noradrenaline. Since adrenaline is secreted by the medulla rather than the cortex, an injury specifically affecting the adrenal cortex would not impair the secretion of adrenaline or noradrenaline.

54. (1) Glucagon – Beta cells (source)
Glucagon is a hormone responsible for increasing blood sugar levels and is produced by the alpha cells of the Islets of Langerhans in the pancreas. Beta cells are responsible for secreting insulin, which lowers blood glucose. Therefore, matching

the mature Graafian follicle to rupture, releasing the secondary oocyte into the fallopian tube. Without this large plasma surge, the process of ovulation would not initiate.

93. (2) Leydig's cells
Testosterone is the primary male sex hormone and is produced by the Leydig's cells, also known as interstitial cells. These cells are located in the connective tissue between the seminiferous tubules of the testes. The production of testosterone is stimulated by luteinizing hormone from the anterior pituitary. This hormone is essential for the development of male tissues and secondary sexual characteristics.

94. (1) enterogastrone
Enterogastrone is a hormone secreted by the duodenal mucosa in response to the presence of fats in the chyme. Its primary function is to inhibit the secretion of gastric juice and slow down the movements of the stomach. This inhibitory action helps to slow down the passage of food, allowing more time for digestion. It effectively stops or reduces gastric secretion.

95. (2) hormone secreted by pituitary that promotes reabsorption of water from glomerular filtrate
Anti-diuretic hormone, also known as vasopressin, is a hormone released by the posterior pituitary gland. Its main function is to promote the reabsorption of water from the glomerular filtrate in the distal tubules and collecting ducts of the nephron. By increasing water permeability, ADH helps the body conserve water and produce more concentrated urine. This is vital for maintaining fluid balance.

96. (4) testis and testosterone.
Leydig's cells are specialized interstitial cells found within the testes of males. Their primary function is the synthesis and secretion of androgens, the most significant of which is testosterone. This hormone is essential for the development of the male reproductive system and the maintenance of secondary sexual characteristics. Therefore, the occurrence of Leydig's cells is specific to the testis for testosterone production.

97. (3) hormone
Insulin is a vital peptide hormone produced by the beta cells of the Islets of Langerhans in the pancreas. It plays a central role in regulating metabolism by lowering blood glucose levels. Insulin achieves this by facilitating the uptake of glucose into cells and promoting its storage as glycogen. It is neither a vitamin nor an enzyme, but a regulatory chemical messenger.

98. (1) Cortisol
Cortisol is a glucocorticoid hormone that exhibits an anti-insulin effect by increasing blood glucose levels. It achieves this by stimulating gluconeogenesis, which is the production of glucose from non-carbohydrate sources, and by inhibiting glucose uptake in certain peripheral tissues. These actions are opposite to those of insulin, which works to lower blood sugar. Therefore, cortisol raises blood glucose during stress.

99. (1) darkening of skin in lower vertebrates
Melanocyte-stimulating hormone is produced by the pars intermedia, or the middle lobe of the pituitary gland. In lower vertebrates, such as fish and amphibians, this hormone is responsible for the darkening of the skin by stimulating the dispersion of melanin pigments within specialized cells called melanophores. This process allows these animals to change their color for camouflage or protection from predators.

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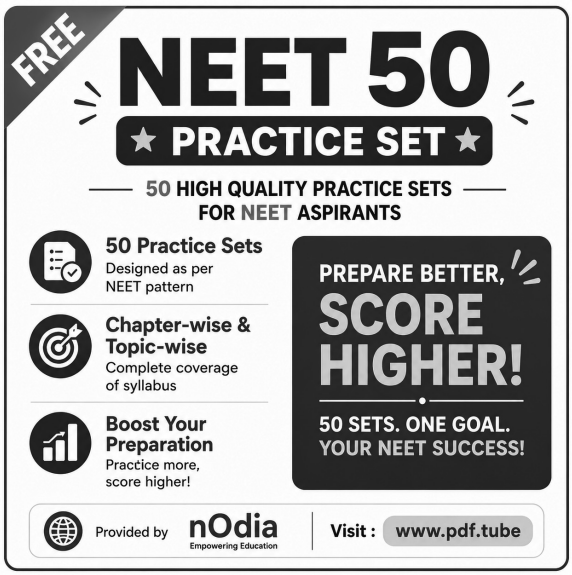

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64. (2) Posterior pituitary lobe
The posterior pituitary lobe, or neurohypophysis, serves as an accumulation and release centre for neurohormones like oxytocin and vasopressin. These hormones are synthesized in the cell bodies of neurons located in the hypothalamus and are then transported along axons to the posterior pituitary. Here, they are stored in terminal ends until they are triggered for release into the general blood circulation.

65. (2) cortisol
Cortisol is a glucocorticoid, which is a type of steroid hormone produced by the adrenal cortex. It plays a central role in regulating glucose metabolism by stimulating gluconeogenesis, which is the production of glucose from non-carbohydrate sources. Cortisol also helps the body manage stress and maintain blood pressure. Among the various corticosteroids, cortisol is the primary hormone responsible for these metabolic functions.

66. (4) Sodium
In the mechanism of hormone action, second messengers are molecules that relay signals from receptors on the cell surface to target molecules inside the cell. Common examples include cyclic AMP, cyclic GMP, and calcium ions. These molecules initiate intracellular biochemical cascades. Sodium ions, however, are not typically classified as second messengers; they primarily function in maintaining osmotic balance and nerve impulse.

67. (1) Luteinising hormone - Failure of ovulation
Luteinising hormone is essential for the reproductive process as it triggers ovulation in females. A deficiency or lack of the LH surge results in the failure of ovulation, leading to infertility. Other choices are incorrect because insulin deficiency causes diabetes mellitus rather than insipidus, and thyroxine deficiency is not linked to tetany. Understanding hormone functions helps in identifying specific diseases.

68. (1) Epinephrine
Epinephrine, also known as adrenaline, is a hormone produced by the adrenal medulla. It is chemically categorized as a catecholamine and is derived from the amino acid tyrosine through metabolic steps. Unlike steroid hormones like estrogen or progesterone, which are lipid-derived, epinephrine belongs to the group of amine hormones that play critical roles in emergency responses and the fight-or-flight reaction.

69. (2) proteins, steroids and biogenic amines
Hormones are chemically diverse molecules categorized into three main groups: proteins, steroids, and biogenic amines. Protein hormones consist of amino acid chains. Steroid hormones are derived from cholesterol and are lipid-soluble. Biogenic amines, such as epinephrine and thyroxine, are modified versions of single amino acids. This chemical variety allows hormones to utilize different mechanisms of action to regulate biological.

70. (3) Parathyroid hormone – Tetany
Parathyroid hormone regulates blood calcium levels by stimulating bone resorption and kidney reabsorption. A deficiency of this hormone leads to low blood calcium, which increases neuromuscular excitability and causes muscle spasms known as tetany. Other matches are incorrect because insulin deficiency causes diabetes mellitus, and prolactin is not linked to cretinism. Therefore, the connection between parathyroid hormone deficiency and tetany is established.

71. (1) excess of STH
Acromegaly is a hormonal disorder that occurs when the anterior pituitary gland produces an excess of growth hormone, also known as somatotrophic hormone, during adulthood. Since the epiphyseal plates have already closed, the bones do not increase in length; instead, they thicken. This results in the characteristic enlargement of the hands, feet, and facial features. It is distinct from gigantism.

72. (1) SA node
Adrenaline is a catecholamine that significantly influences cardiovascular function during stress. It acts directly on the sinoatrial node, which is the natural pacemaker of the heart, to increase the heart rate. By stimulating the SA node, adrenaline ensures a more rapid delivery of oxygen and nutrients to tissues. This action is a key part of the fight-or-flight response.

73. (3) Estrogen
The ovaries are the primary source of estrogen in the female body. If both ovaries are removed, the production of this steroid hormone ceases, leading to a significant decrease in its concentration in

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glucagon with beta cells is physiologically incorrect. The other pairs correctly link somatostatin to delta cells, relaxin to the corpus luteum, and insulin deficiency to diabetes.

55. (3) simple goitre
Simple goitre is a condition characterized by the enlargement of the thyroid gland. It often develops when there is a deficiency of iodine or when toxic agents in food interfere with the synthesis of thyroxine. To compensate for the low hormone levels, the gland grows larger in an attempt to capture more iodine. This condition is distinct from toxic goitre or hyperthyroid states.

56. (2) Norepinephrine - Adrenal medulla - Increases heart beat, rate of respiration and alertness
Norepinephrine is secreted by the adrenal medulla and plays a vital role in the body's emergency response. It increases the heart rate, rate of respiration, and overall alertness to prepare the individual for stress. Other choices are incorrect because vasopressin decreases water loss, glucagon is secreted by alpha cells, and prolactin is produced by the anterior pituitary, not the posterior lobe.

57. (2) myxoedema
Myxoedema is a condition that occurs due to the deficiency of thyroxine in adults. It is characterized by a low basal metabolic rate, significant increase in body weight, and the tendency to retain water in the tissues, leading to puffiness. This disorder differs from cretinism, which affects children. Hypothyroidism is the general state, but myxoedema specifically describes this severe adult clinical presentation.

58. (3) Parathyroid and adrenal
The parathyroid and adrenal glands are purely endocrine glands as their sole function is to secrete hormones directly into the bloodstream. In contrast, organs like the pancreas, testes, and ovaries are mixed glands, performing both endocrine and exocrine functions. For example, the pancreas secretes digestive enzymes through ducts and hormones into the blood, while the testes and ovaries produce gametes.

59. (3) parathormone
Parathormone is secreted by the parathyroid glands and is the primary hormone responsible for increasing blood calcium levels. It achieves this by stimulating bone resorption and enhancing calcium reabsorption in the kidneys. A deficiency of parathormone leads to a significant decrease in blood calcium levels, which can cause muscle spasms. Calcitonin, on the other hand, works to lower blood calcium levels.

60. (1) Adrenaline
Adrenaline, also known as the fight-or-flight hormone, is released by the adrenal medulla during sudden stressful situations or emergencies. When a person feels fear or danger, such as during an earthquake, adrenaline is secreted to increase heart rate, provide a burst of energy, and sharpen focus. This hormonal surge allows the individual to respond rapidly and physically to the perceived threat.

61. (4) Parathyroid
The parathyroid glands secrete parathyroid hormone, which is the primary regulator of calcium and phosphorus metabolism in the human body. This hormone ensures that calcium levels in the blood remain stable by acting on bones, kidneys, and the intestines. If these glands are not functioning properly, the balance of these minerals is disrupted, leading to potential bone weakening and other issues.

62. (3) Endocrine glands regulate neural activity and nervous system regulates endocrine glands.
The human body maintains homeostasis through the integrated action of both the nervous and endocrine systems. Endocrine glands secrete hormones that can influence neural activity, while the nervous system, particularly through the hypothalamus, directly regulates the secretion of various endocrine glands. This reciprocal relationship ensures that the body can respond effectively to both internal changes and external stimuli in a manner.

63. (4) Adrenaline
Adrenaline is a powerful hormone that prepares the body for high-intensity activity. It causes the dilation of blood vessels in skeletal muscles to increase blood flow and enhances oxygen consumption by raising the respiratory rate. Additionally, it promotes gluconeogenesis and glycogenolysis to increase the availability of glucose for energy. These physiological changes collectively ensure the body has the necessary resources for response.

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83. (3) intestine
Cholecystokinin and duocrinin are important hormones produced by the endocrine cells of the small intestine. Cholecystokinin stimulates the gallbladder to release bile and the pancreas to secrete digestive enzymes. Duocrinin promotes the secretion of mucus from Brunner's glands in the duodenum to protect the intestinal lining. These hormones coordinate the digestive process by signaling appropriate organs to release their secretions.

84. (4) lowers calcium level in blood.
Calcitonin is a peptide hormone secreted by the parafollicular cells of the thyroid gland. Its primary function is to lower calcium levels in the blood by inhibiting bone resorption and promoting the deposition of calcium into the bone matrix. This action effectively opposes the effects of parathyroid hormone, which raises blood calcium. These hormones maintain the delicate balance of calcium ions.

85. (4) thyroid.
The thyroid gland secretes hormones, primarily thyroxine, that are essential for regulating the basal metabolic rate in the human body. These hormones influence how the body uses energy, consumes oxygen, and produces heat. They play a vital role in the growth and differentiation of tissues. A properly functioning thyroid is necessary to maintain the overall speed of metabolism throughout.

86. (3) gastrin
Gastrin is a hormone produced by the G-cells in the lining of the stomach and duodenum. When food enters the stomach, gastrin is released into the bloodstream and stimulates the gastric glands to secrete gastric juice, which contains hydrochloric acid and pepsinogen. This process is essential for the initial stages of protein digestion. Gastrin's regulatory role ensures that juices are available.

87. (1) cholecystokinin
Cholecystokinin is a hormone produced by the small intestine in response to the presence of fats and proteins in the chyme. One of its primary functions is to stimulate the contraction of the gallbladder, which releases stored bile into the duodenum. Bile is essential for the emulsification and subsequent digestion of dietary fats. This coordinated action ensures bile availability during digestion.

88. (1) tyrosine
The amino acid tyrosine serves as the biochemical precursor for the synthesis of several important biological molecules. These include the thyroid hormones, such as thyroxine, and the catecholamines, such as adrenaline and noradrenaline. Additionally, the pigment melanin, which provides color to the skin, hair, and eyes, is also derived from tyrosine. Therefore, this amino acid is fundamental to these diverse compounds.

89. (4) Prolactin
Prolactin is a peptide hormone secreted by the anterior pituitary gland. Its primary function in females is to stimulate the development of the mammary glands and promote the production of milk after childbirth. While oxytocin is responsible for the ejection of milk, prolactin is essential for its synthesis. This hormone ensures that the mother can provide adequate nutrition for her newborn child.

90. (2) Thyroid
The thyroid gland is unique among endocrine glands because it stores its hormonal secretions in an extracellular space before releasing them into the blood. The hormones are stored as a protein complex called thyroglobulin within the follicles of the gland. When needed, the active hormones, thyroxine and triiodothyronine, are discharged into the circulatory system to regulate the body's vital metabolic processes.

91. (2) not respond to the hormone
Hormones exert their effects by binding to specific receptor molecules located either on the cell membrane or inside the target cell. These receptors are essential for the cell to recognize and respond to the hormonal signal. If the receptor molecules are removed from a target organ, the hormone will no longer be able to initiate any physiological response. Consequently, the organ fails.

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92. (1) LH
In the human female reproductive cycle, ovulation is triggered by a sudden and significant increase in the concentration of luteinizing hormone in the blood. This phenomenon, known as the LH surge, occurs mid-cycle and causes

to provide energy. This hormonal surge prepares the individual to face a threat or flee.

38. (2) Melatonin - pineal gland, regulates the normal rhythm of sleepwake cycle.
Melatonin is a hormone secreted by the pineal gland that plays a fundamental role in regulating the body's circadian rhythms. Its primary function is to maintain the normal 24-hour sleep-wake cycle and influence other diurnal patterns. While oxytocin is released by the posterior pituitary, its main role is milk ejection. Melatonin's specific source and function are correctly identified in this comparison.

39. (3) deficiency of iodine in diet
Iodine is an essential micronutrient required for the synthesis of thyroid hormones. A deficiency of iodine in a pregnant woman's diet can lead to hypothyroidism, which severely affects fetal development. This often results in cretinism, a condition characterized by stunted physical growth, mental retardation, and abnormal skin. Ensuring adequate iodine intake is critical during pregnancy to prevent these irreversible developmental issues.

40. (1) Thyroid gland - Thyroxine - Lack of iodine in diet results in goitre
The thyroid gland produces thyroxine, which is essential for regulating metabolism. A lack of iodine in the diet prevents the synthesis of this hormone, leading to the enlargement of the gland, a condition known as goitre. Other matches are incorrect because oxytocin is from the posterior pituitary, growth hormone is from the anterior pituitary, and the corpus luteum secretes progesterone.

41. (3) Leydig's cells - Androgen - Initiates the production of sperms
Leydig's cells, also known as interstitial cells, are located in the testes and are responsible for the production of androgens, primarily testosterone. These hormones play a crucial role in initiating and maintaining the process of spermatogenesis, which is the production of sperm. They also stimulate the development of male secondary sexual characteristics. Therefore, the connection between Leydig's cells and androgen-mediated sperm production is essential.

42. (1) (i) and (iii)
Nor-epinephrine is a catecholamine that functions as both a hormone and a neurotransmitter. It is primarily released by the sympathetic nerve fibers and the adrenal medulla during stress. This chemical increases the heart rate and blood pressure by stimulating the heart and constricting blood vessels. It is not associated with parasympathetic fibers, which typically have opposing effects on the cardiovascular system.

43. (2) Decreases blood glucose levels by forming glycogen.
Insulin is a hypoglycemic hormone secreted by the beta cells of the pancreas. It works to decrease blood glucose levels by facilitating the cellular uptake of glucose into hepatocytes and adipocytes. Furthermore, insulin promotes the conversion of glucose into glycogen for storage, a process called glycogenesis. By increasing glucose utilization and storage, insulin maintains blood sugar within a normal physiological range.

44. (1) Non-nutrient chemicals produced by the body in trace amounts that act as intercellular messenger are known as hormones.
Hormones are defined as non-nutrient chemicals produced by the body in trace amounts that function as intercellular messengers. They are secreted by endocrine glands directly into the blood. While the pituitary gland secretes many hormones, releasing hormones are produced by the hypothalamus. Additionally, organs such as the heart, kidney, and liver also possess endocrine tissues that secrete vital hormones for body regulation.

45. (2) As tissue X develops, it secretes enzymes that inhibit the development of tissue Y.
Feedback mechanisms in development involve one process or tissue influencing another to maintain balance. In this context, as tissue X develops, it may secrete specific enzymes or signals that inhibit or regulate the growth of tissue Y. This inhibitory interaction is a classic example of negative feedback, ensuring that tissues grow and differentiate in a coordinated and controlled manner during development.

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CHAPTER 20

Sexual Reproduction in Flowering Plants

2026 (RE-NEET)

1. Which of the following plant produces non-albuminous seeds?
(1) Barley
(2) Pea
(3) Wheat
(4) Maize

2026 (RE-NEET)

2. If the diploid chromosome number of a typical angiosperm is 36, what would be the chromosome number in its endosperm?
(1) 54
(2) 72
(3) 18
(4) 36

2026 (RE-NEET)

3. How many theca are present in each lobe of a typical bilobed angiosperm anther?
(1) 8
(2) 12
(3) 2
(4) 6

2026 (RE-NEET)

4. Which structure in the female gametophyte of an angiosperm helps in guiding the pollen tube for fertilizing the eggs?
(1) Central cells
(2) Polar nucleus
(3) Antipodals
(4) Synergids

2026 (CANCELLED)

5. Arrange the following in the correct developmental sequence related to microsporogenesis:
A. Microspore tetrads
B. Sporogenous tissue
C. Pollen grains
D. Pollen mother cells
(1) D, A, C, B
(2) B, D, A, C
(3) B, D, C, A
(4) A, D, C, B
Choose the correct answer from the options given below :

2026 (CANCELLED)

6. Which one of the following is a triploid cell?
(1) Synergid
(2) Central cell
(3) Zygote
(4) Primary endosperm cell

2026 (CANCELLED)

7. Which one of the following types of pollination brings genetically different types of pollen grains to the stigma?
(1) Autogamy (2) Xenogamy
(3) Geitonogamy (4) Cleistogamy

2026 (CANCELLED)

8. Which one of the following is an appropriate example of 'sexual deceit'?
(1) Female wasp and fig
(2) Ophrys and bumblebee
(3) Sea anemone and clown fish
(4) Cuckoo and crow

2025

9. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): A typical unfertilised, angiosperm embryo sac at maturity is 8 nucleate and 7-celled.
Reason (R): The egg apparatus has 2 polar nuclei.
In the light of the above statements, choose the correct answer from the options given below:
(1) A is true but R is false.
(2) A is false but R is true.
(3) Both A and R are true and R is the correct explanation of A.
(4) Both A and R are true but R is not the correct explanation of A.

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2025

10. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Both wind and water pollinated flowers are not very colourful and do not produce nectar.
Reason (R): The flowers produce enormous amount of pollen grains in wind and water

(3) Sporopollenin can withstand high temperatures as well as strong acids and alkalis.
(4) Sporopollenin can withstand high temperatures but not strong acids.

2013

78. Seed coat is not thin, membranous in
(1) groundnut
(2) gram
(3) maize
(4) coconut.

2013

79. Perisperm differs from endosperm in
(1) being a diploid tissue
(2) its formation by fusion of secondary nucleus with several sperms
(3) being a haploid tissue
(4) having no reserve food.

Karnataka NEET 2013

80. Albuminous seeds store their reserve food mainly in
(1) endosperm
(2) cotyledons
(3) hypocotyl
(4) perisperm.

Karnataka NEET 2013

81. The viability of seeds is tested by
(1) 2, 6 dichlorophenol indophenol
(2) 2, 3, 5 triphenyl tetrazolium chloride
(3) DMSO
(4) Safranine.

2012

82. Both, autogamy and geitonogamy are prevented in
(1) papaya
(2) cucumber
(3) castor
(4) maize.

2012

83. An organic substance that can withstand environmental extremes and cannot be degraded by any enzyme is
(1) cuticle
(2) sporopollenin
(3) lignin
(4) cellulose.

2012

84. Even in absence of pollinating agents seed-setting is assured in
(1) Commelina
(2) Zostera
(3) Salvia
(4) fig.

Mains 2012

85. What is the function of germ pore?
(1) Emergence of radicle
(2) Absorption of water for seed germination
(3) Initiation of pollen tube
(4) Release of male gametes

Mains 2012

86. Plants with ovaries having only one or a few ovules, are generally pollinated by
(1) bees
(2) butterflies
(3) birds
(4) wind.

Mains 2012

87. Which one of the following statements is wrong?
(1) When pollen is shed at two-celled stage, double fertilisation does not take place.
(2) Vegetative cell is larger than generative cell.
(3) Pollen grains in some plants remain viable for months.
(4) Intine is made up of cellulose and pectin.

2011

88. Filiform apparatus is a characteristic feature of
(1) suspensor
(2) egg
(3) synergid
(4) zygote.

2011

89. Which one of the following pollinations is autogamous?
(1) Geitonogamy
(2) Xenogamy
(3) Chasmogamy
(4) Cleistogamy

2011

90. Wind pollination is common in
(1) legumes
(2) lilies
(3) grasses
(4) orchids.

Mains 2011

91. In angiosperms, functional megaspore develops into
(1) embryo sac
(2) ovule

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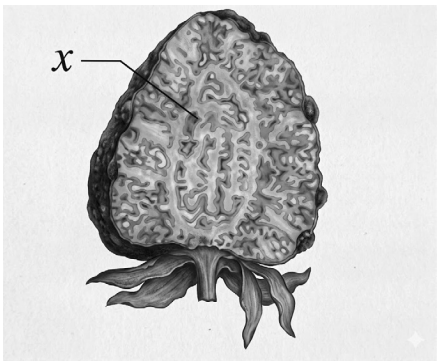
(1) Wind pollinated plant inflorescence showing flowers with well exposed stamens.
(2) Water pollinated flower showing stamens with mucilaginous covering.
(3) Cleistogamous flowers showing autogamy.
(4) Compact inflorescence showing complete autogamy.

RE-EXAM 2024

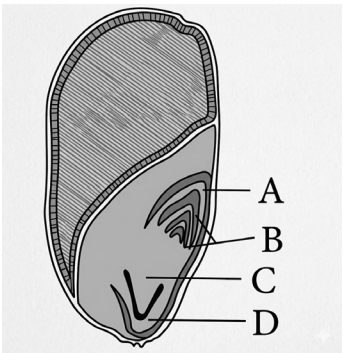
18. The part marked as 'x' in the given figure is



(1) endosperm
(2) thalamus
(3) endocarp
(4) mesocarp.

2024

19. Identify the part of the seed from the given figure which is destined to form root when the seed germinates.



(1) A (2) B
(3) C (4) D

Manipur NEET 2023

20. In which of the following sets of families, the pollen grains are viable for months?
(1) Solanaceae, Poaceae and Liliaceae
(2) Brassicaceae, Liliaceae and Poaceae
(3) Rosaceae, Liliaceae and Poaceae
(4) Leguminosae, Solanaceae and Rosaceae

Manipur NEET 2023

21. Transfer of pollen grains from anther to stigma of another flower of same plant is known as
(1) geitonogamy
(2) xenogamy
(3) autogamy
(4) cleistogamy.

Manipur NEET 2023

22. In angiosperms, the correct sequence of events in formation of female gametophyte in the ovule is
(A) 3 successive free nuclear divisions of functional megaspore.
(B) Degeneration of 3 megaspores.
(C) Meiotic division in megaspore mother cell.
(D) Migration of 3 nuclei towards each pole.
(E) Formation of wall resulting in seven celled embryo sac.
Choose the correct answer from the options given below.
(1) (A), (B), (C), (D), (E)
(2) (C), (E), (A), (D), (B)
(3) (B), (C), (A), (D), (E)
(4) (C), (B), (A), (D), (E)

2023

23. What is the function of tassels in the corn cob?
(1) To disperse pollen grains
(2) To protect seeds
(3) To attract insects
(4) To trap pollen grains

2023

24. Large, colourful, fragrant flowers with nectar are seen in
(1) bat pollinated plants
(2) wind pollinated plants
(3) insect pollinated plants
(4) bird pollinated plants.

2023

25. In angiosperm, the haploid, diploid and triploid structures of a fertilized embryo sac sequentially are
(1) Synergids, zygote and primary endosperm nucleus
(2) Synergids, antipodals and polar nuclei
(3) Synergids, primary endosperm nucleus and zygote
(4) Antipodals, synergids, and primary endosperm nucleus.

2022

26. Identify the incorrect statement related to pollination.

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2007

103. Which one of the following is surrounded by a callose wall?
(1) Male gamete
(2) Egg
(3) Pollen grain
(4) Microspore mother cell

2007

104. Two plants can be conclusively said to belong to the same species if they
(1) have more than 90 percent similar genes
(2) look similar and possess identical secondary metabolites
(3) have same number of chromosomes
(4) can reproduce freely with each other and form seeds.

2006

105. The arrangement of the nuclei in a normal embryo sac in the dicot plants is
(1) 3 + 3 + 2
(2) 2 + 4 + 2
(3) 3 + 2 + 3
(4) 2 + 3 + 3.

2006

106. In a cereal grain the single cotyledon of embryo is represented by
(1) coleoptile
(2) coleorhiza
(3) scutellum
(4) prophyll.

2005

107. Which one of the following represents an ovule, where the embryo sac becomes horse-shoe shaped and the funiculus and micropyle are close to each other?
(1) Amphitropous
(2) Circinotropous
(3) Atropous
(4) Anatropous

2005

108. Through which cell of the embryo sac, does the pollen tube enter the embryo sac?
(1) Egg cell
(2) Persistant synergid
(3) Degenerated synergids
(4) Central cell

2005

109. In a type of apomixis known as adventive embryony, embryos develop directly from the
(1) nucellus or integuments
(2) zygote
(3) synergids or antipodals in an embryo sac
(4) accessory embryo sacs in the ovule.

2004

110. An ovule which becomes curved so that the nucellus and embryo sac lie at right angles to the funicle is
(1) hemitropous
(2) campylotropous
(3) anatropous
(4) orthotropous.

2004

111. Anthesis is a phenomenon which refers to
(1) reception of pollen by stigma
(2) formation of pollen
(3) development of anther
(4) opening of flower bud.

2003

112. In a flowering plant, archesporium gives rise to
(1) only the wall of the sporangium
(2) both wall and the sporogenous cells
(3) wall and the tapetum
(4) only tapetum and sporogenous cells.

NODIA

2002

113. In angiosperm, all the four microspores of tetrad are covered by a layer which is formed by
(1) pectocellulose
(2) callose
(3) cellulose
(4) sporopollenin.

2002

114. What is the direction of micropyle in anatropous ovule?
(1) Upward
(2) Downward
(3) Right
(4) Left

2002

115. In angiosperms, pollen tube liberate their male gametes into the
(1) central cell
(2) antipodal cells
(3) egg cell
(4) synergids.

2001

116. In grasses what happens in microspore mother cell for the formation of mature pollen grains?
(1) One meiotic and two mitotic divisions
(2) One meiotic and one mitotic division
(3) One meiotic division
(4) One mitotic division

(3) Flowers emerge above water surface, and pollen is carried by wind.
(4) Male flowers are carried by water currents to female flowers at surface of water.

Odisha NEET 2019

36. In which one of the following, both autogamy and geitonogamy are prevented?
(1) Wheat
(2) Papaya
(3) Castor
(4) Maize

2019

37. What is the fate of the male gametes discharged in the synergid?
(1) One fuses with the egg and other fuses with central cell nuclei.
(2) One fuses with the egg, other(s) degenerates in the synergid.
(3) All fuse with the egg.
(4) One fuses with the egg, other(s) fuse(s) with synergid nucleus.

2019

38. Persistent nucellus in the seed is known as
(1) tegmen
(2) chalaza
(3) perisperm
(4) hilum.

2019

39. Which one of the following statements regarding post-fertilisation development in flowering plants is incorrect?
(1) Ovules develop into embryo sac.
(2) Ovary develops into fruit.
(3) Zygote develops into embryo.
(4) Central cell develops into endosperm.

2018

40. Pollen grains can be stored for several years in liquid nitrogen having a temperature of
(1) -120°C
(2) -80°C
(3) -196°C
(4) -160°C.

2018

41. Which of the following has proved helpful in preserving pollen as fossils?
(1) Pollenkitt
(2) Cellulosic intine
(3) Oil content
(4) Sporopollenin

2018

42. Winged pollen grains are present in
(1) mustard
(2) Cycas
(3) mango
(4) Pinus.

2018

43. Double fertilisation is
(1) fusion of two male gametes of a pollen tube with two different eggs
(2) fusion of one male gamete with two polar nuclei
(3) fusion of two male gametes with one egg
(4) syngamy and triple fusion.

2017

44. Functional megaspore in an angiosperm develops into an
(1) endosperm (2) embryo sac
(3) embryo (4) ovule.

2017

45. Attractants and rewards are required for
(1) entomophily (2) hydrophily
(3) cleistogamy (4) anemophily.

2017

46. Flowers which have single ovule in the ovary and are packed into inflorescence are usually pollinated by
(1) bee (2) wind
(3) bat (4) water.

2017

47. A dioecious flowering plant prevents both
(1) autogamy and geitonogamy
(2) geitonogamy and xenogamy
(3) cleistogamy and xenogamy
(4) autogamy and xenogamy.

2017

48. Double fertilisation is exhibited by
(1) algae
(2) fungi
(3) angiosperms
(4) gymnosperms.

NEET-II 2016

49. In majority of angiosperms,
(1) egg has a filiform apparatus
(2) there are numerous antipodal cells
(3) reduction division occurs in the megaspore mother cells
(4) a small central cell is present in that embryo sac.

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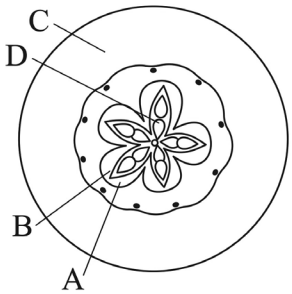
(1) Pollination by water is quite rare in flowering plants.
(2) Pollination by wind is more common amongst abiotic pollination.
(3) Flowers produce foul odours to attract flies and beetles to get pollinated.
(4) Moths and butterflies are the most dominant pollinating agents among insects.

2022

27. Given below are two statements :
Statement I : Cleistogamous flowers are invariably autogamous.
Statement II : Cleistogamy is disadvantageous as there is no chance for cross pollination.
In the light of the above statements, choose the correct answer from the options given below :
(1) Both Statement I and Statement II are correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is correct but Statement II is incorrect
(4) Statement I is incorrect but Statement II is correct.

2022

28. Which part of the fruit, labelled in the given figure makes it a false fruit?



(1) A → Mesocarp
(2) B → Endocarp
(3) C → Thalamus
(4) D → Seed

2021

29. The term used for transfer of pollen grains from anthers of one plant to stigma of a different plant which, during pollination, brings genetically different types of pollen grains to stigma, is
(1) cleistogamy
(2) xenogamy
(3) geitonogamy
(4) chasmogamy.

2021

30. A typical angiosperm embryo sac at maturity is
(1) 8-nucleate and 8-celled
(2) 8-nucleate and 7-celled
(3) 7-nucleate and 8-celled
(4) 7-nucleate and 7-celled.

2021

31. In some members of which of the following pairs of families, pollen grains retain their viability for months after release?
(1) Rosaceae : Leguminosae
(2) Poaceae : Rosaceae
(3) Poaceae : Leguminosae
(4) Poaceae : Solanaceae

2020

32. The plant parts which consist of two generations-one within the other
(1) pollen grains inside the anther
(2) germinated pollen grain with two male gametes
(3) seed inside the fruit
(4) embryo sac inside the ovule
(1) (1) only
(2) (1), (2), and (3)
(3) (3) and (4)
(4) (1) and (4).

NODIA

2020

33. In water hyacinth and water lily, pollination takes place by
(1) insects or wind
(2) water currents only
(3) wind and water
(4) insects and water.

Odisha NEET 2019

34. Which is the most common type of embryo sac in angiosperms ?
(1) Tetrasporic with one mitotic stage of divisions
(2) Monosporic with three sequential mitotic divisions
(3) Monosporic with two sequential mitotic divisions
(4) Bisporic with two sequential mitotic divisions

Odisha NEET 2019

35. What type of pollination takes place in Vallisneria?
(1) Pollination occurs in submerged condition by water.
(2) Flowers emerge above surface of water, and pollination occurs by insects.

2015 Cancelled

63. The hilum is a scar on the
(1) fruit, where style was present
(2) seed, where micropyle was present
(3) seed, where funicle was attached
(4) fruit, where it was attached to pedicel.

2015 Cancelled

64. Transmission tissue is characteristic feature of
(1) dry stigma
(2) wet stigma
(3) hollow style
(4) solid style.

2015

65. Coconut water from a tender coconut is
(1) innermost layers of the seed coat
(2) degenerated nucellus
(3) immature embryo
(4) free nuclear endosperm.

2015

66. Which one of the following fruits is parthenocarpic?
(1) Jackfruit
(2) Banana
(3) Brinjal
(4) Apple

2014

67. Geitonogamy involves
(1) fertilisation of a flower by the pollen from another flower of the same plant
(2) fertilisation of a flower by the pollen from the same flower
(3) fertilisation of a flower by the pollen from a flower of another plant in the same population
(4) fertilisation of a flower by the pollen from a flower of another plant belonging to a distant population.

2014

68. Pollen tablets are available in the market for
(1) in vitro fertilisation
(2) breeding programmes
(3) supplementing food
(4) ex situ conservation.

2014

69. Function of filiform apparatus is to
(1) recognise the suitable pollen at stigma
(2) stimulate division of generative cell
(3) produce nectar
(4) guide the entry of pollen tube.

2014

70. Non-albuminous seed is produced in
(1) maize
(2) castor
(3) wheat
(4) pea.

2013

71. Advantage of cleistogamy is
(1) no dependence on pollinators
(2) vivipary
(3) higher genetic variability
(4) more vigorous offspring.

2013

72. Megasporangium is equivalent to
(1) nucellus
(2) ovule
(3) embryo sac
(4) fruit.

2013

73. Which one of the following statements is correct?
(1) Endothecium produces the microspores.
(2) Tapetum nourishes the developing pollen.
(3) Hard outer layer of pollen is called intine.
(4) Sporogenous tissue is haploid.

Karnataka NEET 2013

74. Animal vectors are required for pollination in
(1) Vallisneria
(2) mulberry
(3) cucumber
(4) maize.

Karnataka NEET 2013

75. Megaspores are produced from the megaspore mother cells after
(1) mitotic division
(2) formation of thick wall
(3) differentiation
(4) meiotic division.

Karnataka NEET 2013

76. Which one of the following statements is correct?
(1) Cleistogamous flowers are always autogamous.
(2) Xenogamy occurs only by wind pollination.
(3) Chasmogamous flowers do not open at all.
(4) Geitonogamy involves the pollen and stigma of flowers of different plants.

Karnataka NEET 2013

77. Which of the following statements is correct?
(1) Sporopollenin can be degraded by enzymes.
(2) Sporopollenin is made up of inorganic materials.

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pollinated flowers.

In the light of the above statements, choose the correct answer from the options given below:

(1) A is true but R is false.
(2) A is false but R is true.
(3) Both A and R are true and R is the correct explanation of A.
(4) Both A and R are true but R is not the correct explanation of A.

2025

11. How many meiotic and mitotic divisions need to occur for the development of a mature female gametophyte from the megaspore mother cell in an angiosperm plant?

(1) 1 Meiosis and 3 Mitosis
(2) No Meiosis and 2 Mitosis
(3) 2 Meiosis and 3 Mitosis
(4) 1 Meiosis and 2 Mitosis

2025

12. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Cells of the tapetum possess dense cytoplasm and generally have more than one nucleus.

Reason (R): Presence of more than one nucleus in the tapetum increases the efficiency of nourishing the developing microspore mother cells.

In light of the above statements, choose the most appropriate answer from the options given below:

(1) A is true but R is false.
(2) A is false but R is true.
(3) Both A and R are true and R is the correct explanation of A.
(4) Both A and R are true but R is not the correct explanation of A.

2025

13. Match List I with List II.

	List-I		List-II
A.	Scutellum	I.	Persistent nucellus
B.	Non-albuminous seed	II.	Cotyledon of monocot seed
C.	Epiblast	III.	Groundnut
D.	Perisperm	IV.	Rudimentary cotyledon

Choose the option with all correct matches.

(1) A-IV, B-III, C-I, D-II
(2) A-II, B-IV, C-III, D-I
(3) A-II, B-III, C-IV, D-I
(4) A-IV, B-III, C-II, D-I

RE-EXAM 2024

14. Which part of the ovule stores reserve food materials?

(1) Nucellus
(2) Integument
(3) Placenta
(4) Funicle

RE-EXAM 2024

15. Pollen grains remain preserved as fossils due to the presence of

(1) epidermal layer
(2) tapetum
(3) exine layer
(4) intine layer.

2024

16. Identify the set of correct statements

A. The flowers of Vallisneria are colourful and produce nectar.
B. The flowers of water lily are not pollinated by water.
C. In most of water-pollinated species, the pollen grains are protected from wetting.
D. Pollen grains of some hydrophytes are long and ribbon like.
E. In some hydrophytes, the pollen grains are carried passively inside water.

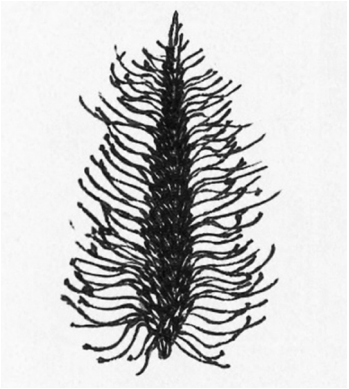
Choose the correct answer from the options given below

(1) C, D and E only
(2) A, B, C and D only
(3) A, C, D and E only
(4) B, C, D and E only

NODIA

2024

17. Identify the correct description about the given figure.



(3) endosperm
(4) pollen sac.

2011

92. Nucellar polyembryony is reported in species of
(1) Citrus
(2) Gossypium
(3) Triticum
(4) Brassica.

Mains 2011

93. What is common between vegetative reproduction and apomixis?
(1) Both are applicable to only dicot plants.
(2) Both bypass the flowering phase.
(3) Both occur round the year.
(4) Both produce progeny identical to the parent.

2010

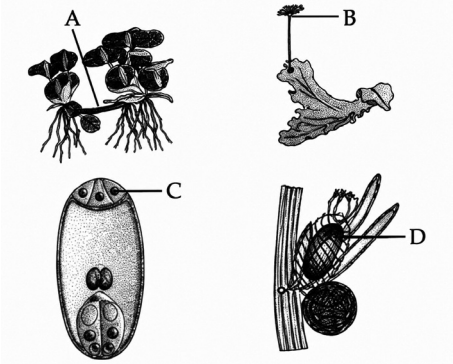
94. Transfer of pollen grains from the anther to the stigma of another flower of the same plant is called
(1) xenogamy
(2) geitonogamy
(3) karyogamy
(4) autogamy.

2010

95. Wind pollinated flowers are
(1) small, brightly coloured, producing large number of pollen grains
(2) small, producing large number of dry pollen grains
(3) large producing abundant nectar and pollen
(4) small, producing nectar and dry pollen.

Mains 2010

96. Examine the figures (A-D) given below and select the right option out of (a - d), in which all the four structures A, B, C and D are identified correctly.



	A	B	C	D
(1)	Rhizome	Sporangiophore	Polar cell	Globule
(2)	Runner	Archegoniophore	Synergid	Antheridium
(3)	Offset	Antheridiophore	Antipodals	Oogonium
(4)	Sucker	Seta	Megaspore mother cell	Gemma cup

2010

97. Apomictic embryos in Citrus arise from
(1) synergids
(2) maternal sporophytic tissue in ovule
(3) antipodal cells
(4) diploid egg.

2008

98. Which one of the following pairs of plant structures has haploid number of chromosomes?
(1) Nucellus and antipodal cells
(2) Egg nucleus and secondary nucleus
(3) Megaspore mother cell and antipodal cells
(4) Egg cell and antipodal cells

2008

99. What does the filiform apparatus do at the entrance into ovule?
(1) It brings about opening of the pollen tube.
(2) It guides pollen tube from a synergid to egg.
(3) It helps in the entry of pollen tube into a synergid.
(4) It prevents entry of more than one pollen tube into the embryo sac.

2008

100. Unisexuality of flowers prevents
(1) geitonogamy, but not xenogamy
(2) autogamy and geitonogamy
(3) autogamy, but not geitonogamy
(4) both geitonogamy and xenogamy.

Mains 2008

101. Which one of the following is resistant to enzyme action?
(1) Pollen exine
(2) Leaf cuticle
(3) Cork
(4) Wood fibre

2007

102. Male gametes in angiosperms are formed by the division of
(1) generative cell
(2) vegetative cell
(3) microspore mother cell
(4) microspore.

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NEET-II 2016

50. Pollination in water hyacinth and water lily is brought about by the agency of
(1) water
(2) insects or wind
(3) birds
(4) bats.

NEET-II 2016

51. The ovule of an angiosperm is technically equivalent to
(1) megasporangium
(2) megasporophyll
(3) megaspore mother cell
(4) megaspore.

NEET-I 2016

52. Which one of the following statements is not true?
(1) Pollen grains of many species cause severe allergies.
(2) Stored pollen in liquid nitrogen can be used in the crop breeding programmes.
(3) Tapetum helps in the dehiscence of anther.
(4) Exine of pollen grains is made up of sporopollenin.

NEET-I 2016

53. Which of the following statements is not correct?
(1) Pollen germination and pollen tube growth are regulated by chemical components of pollen interacting with those of the pistil.
(2) Some reptiles have also been reported as pollinators in some plant species.
(3) Pollen grains of many species can germinate on the stigma of a flower, but only one pollen tube of the same species grows into the style.
(4) Insects that consume pollen or nectar without bringing about pollination are called pollen/nectar robbers.

NEET-I 2016

54. Proximal end of the filament of stamen is attached to the
(1) placenta
(2) thalamus or petal
(3) anther
(4) connective.

NEET-I 2016

55. The coconut water from tender coconut represents
(1) free nuclear proembryo
(2) free nuclear endosperm
(3) endocarp
(4) fleshy mesocarp.

NEET-I 2016

56. Seed formation without fertilisation in flowering plants involves the process of
(1) somatic hybridisation
(2) apomixis
(3) sporulation
(4) budding.

2015

57. Filiform apparatus is characteristic feature of
(1) aleurone cell
(2) synergids
(3) generative cell
(4) nucellar embryo.

2015

58. In angiosperms, microsporogenesis and megasporogenesis
(1) involve meiosis
(2) occur in ovule
(3) occur in anther
(4) form gametes without further divisions.

NODIA

2015

59. Male gametophyte in angiosperms produces
(1) single sperm and two vegetative cells
(2) three sperms
(3) two sperms and a vegetative cell
(4) single sperm and a vegetative cell.

2015 Cancelled

60. Which of the following are the important floral rewards to the animal pollinators ?
(1) Floral fragrance and calcium crystals
(2) Protein pellicle and stigmatic exudates
(3) Colour and large size of flower
(4) Nectar and pollen grains

2015 Cancelled

61. Which one of the following may require pollinators, but is genetically similar to autogamy?
(1) Apogamy (2) Cleistogamy
(3) Geitonogamy (4) Xenogamy

2015 Cancelled

62. Which one of the following statements is not true?
(1) The flowers pollinated by flies and bats secrete foul odour to attract them.
(2) Honey is made by bees by digesting pollen collected from flowers.
(3) Pollen grains are rich in nutrients and they are used in the form of tablets and syrups.
(4) Pollen grains of some plants cause severe allergies and bronchial afflictions in some people.

2001

117. Anemophily type of pollination is found in
(1) Salvia
(2) bottlebrush
(3) Vallisneria
(4) coconut.

2001

118. Adventive embryony in Citrus is due to
(1) nucellus
(2) integuments
(3) zygotic embryo
(4) fertilized egg.

2000

119. Eight nucleated embryo sac is
(1) only monosporic
(2) only biesporic
(3) only tetrasporic
(4) any of these.

2000

120. Endosperm is formed during the double fertilisation by
(1) two polar nuclei and one male gamete
(2) one polar nuclei and one male gamete
(3) ovum and male gamete
(4) two polar nuclei and two male gametes.

1998, 1996

121. The role of double fertilisation in angiosperms is to produce
(1) cotyledons
(2) endocarp
(3) endosperm
(4) integuments.

1998

122. The embryo in sunflower has
(1) two cotyledons
(2) many cotyledons
(3) no cotyledon
(4) one cotyledon.

1996

123. If there are 4 cells in anthers, what will be the number of pollen grains?
(1) 16 (2) 12
(3) 8 (4) 4

1995

124. The anthesis is a phenomenon, which refers to
(1) development of anthers
(2) opening of flower bud
(3) stigma receptors
(4) all of these.

1995

125. In an angiosperm, how many microspore mother cells are required to produce 100 pollen grains?
(1) 75
(2) 100
(3) 25
(4) 50

1995

126. The polyembryony commonly occurs in
(1) tomato
(2) potato
(3) Citrus
(4) turmeric.

1994

127. When pollen of a flower is transferred to the stigma of another flower of the same plant, the pollination is referred to as
(1) autogamy
(2) geitonogamy
(3) xenogamy
(4) allogamy.

1994

128. Embryo sac represents
(1) megaspore
(2) megagametophyte
(3) megasporophyll
(4) megagamete.

1993

129. Number of meiotic divisions required to produce 200/400 seeds of pea would be
(1) 200/400
(2) 400/800
(3) 300/600
(4) 250/500.

1993

130. Ovule is straight with funiculus, embryo sac, chalaza and micropyle lying on one straight line. It is
(1) orthotropous
(2) anatropous
(3) campylotropous
(4) amphitropous.

1993

131. Double fertilisation is characteristic of
(1) angiosperms
(2) anatropous
(3) gymnosperms
(4) bryophytes.

NODIA

ANSWERS

1. (2) Pea
Non-albuminous (ex-albuminous) seeds lack residual endosperm at maturity because it is fully consumed during embryo development, as in pea, bean and groundnut. Barley, wheat and maize are albuminous (endospermic) seeds.

2. (1) 54
The endosperm is triploid (3n), formed by triple fusion of one male gamete with two polar nuclei. If $2n = 36$, then $n = 18$, and the triploid endosperm $= 3n = 3 \times 18 = 54$ chromosomes.

3. (3) 2
A typical angiosperm anther is bilobed, and each lobe is bithecous, that is, it contains two theca. Each theca encloses two microsporangia. Therefore each lobe of the anther has two theca, making the anther tetrasporangiate.

4. (4) Synergids
The synergids, at the micropylar end of the embryo sac, contain the filiform apparatus. This structure guides the entry of the pollen tube into the synergid towards the egg, aiding fertilisation.

5. (2) B, D, A, C
Microsporogenesis begins with sporogenous tissue (B) in the anther, whose cells become pollen mother cells (D). Each pollen mother cell undergoes meiosis to form microspore tetrads (A). The microspores then dissociate and mature into pollen grains (C), giving the sequence B, D, A, C.

6. (4) Primary endosperm cell
The primary endosperm cell is formed by triple fusion, where one male gamete (n) fuses with two polar nuclei (n + n) of the central cell, making it triploid (3n). Synergids and zygote-forming gametes are haploid, and the zygote itself is diploid (2n).

7. (2) Xenogamy
Xenogamy is cross-pollination between two genetically different plants, transferring pollen from one plant to the stigma of another. This brings genetically different pollen to the stigma. Autogamy, geitonogamy and cleistogamy all involve pollen from the same plant, which is genetically identical.

8. (2) Ophrys and bumblebee
In sexual deceit, one petal of the orchid Ophrys resembles a female bumblebee in size, colour and markings. The male bee is deceived and pseudocopulates with the flower, transferring pollen in the process. This pollination strategy based on mimicry is a classic example of sexual deceit.

9. (1) A is true but R is false.
The typical mature angiosperm embryo sac contains eight nuclei distributed within seven distinct cells. This structure includes three antipodal cells, two synergids, one egg cell, and a large central cell. While the central cell houses two polar nuclei, the egg apparatus itself consists strictly of the egg cell and two synergids, making the reason statement factually incorrect.

10. (4) Both A and R are true but R is not the correct explanation of A.
Flowers pollinated by wind or water do not need to attract animals, so they lack nectar and bright colors. To ensure successful pollination despite the randomness of abiotic factors, these plants produce massive amounts of pollen. While both statements are true, the high pollen production does not explain why the flowers lack color or nectar rewards.

11. (1) 1 Meiosis and 3 Mitosis
A megaspore mother cell undergoes one meiotic division to produce four haploid megaspores. Typically, three degenerate and one remains functional. The functional megaspore then undergoes three successive rounds of mitotic nuclear divisions. These divisions lead to the formation of an eight-nucleate embryo sac, which eventually organizes into the seven-celled mature female gametophyte necessary for successful angiosperm reproduction.

12. (3) Both A and R are true and R is the correct explanation of A.
The tapetum is the innermost wall layer of the microsporangium, serving a vital nutritive role

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1989

147. Nucellar embryo is
(1) amphimictic haploid
(2) amphimictic diploid
(3) apomictic haploid
(4) apomictic diploid.

1989

148. Development of an organism from female gamete/egg without involving fertilization is
(1) adventitive embryony
(2) polyembryony
(3) parthenocarpy
(4) parthenogenesis.

1988

149. Total number of meiotic divisions required for forming 100 zygotes/100 grains of wheat is
(1) 100
(2) 75
(3) 125
(4) 50.

1988

150. Male gametophyte of angiosperms is shed at
(1) four celled pollen grain
(2) three celled pollen grain
(3) microspore mother cell
(4) anther.

1988

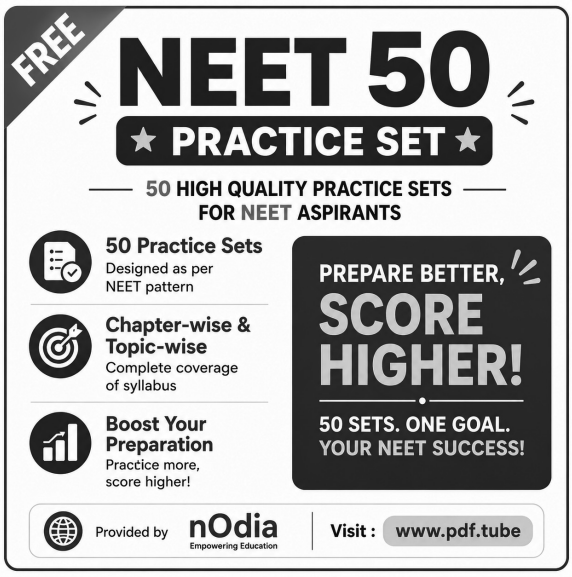
151. Double fertilisation and triple fusion were discovered by
(1) Hofmeister
(2) Nawaschin and Guignard
(3) Leeuwenhoek
(4) Strasburger.

1988

152. Formation of gametophyte directly from sporophyte without meiosis is
(1) apospory
(2) apogamy
(3) parthenogenesis
(4) amphimixis.

1988

153. Prothallus (gametophyte) gives rise to fern plant (sporophyte) without fertilization. It is
(1) apospory
(2) apogamy
(3) parthenocarpy
(4) parthenogenesis.



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22. (4) (C), (B), (A), (D), (E)
Female gametophyte formation starts with a megaspore mother cell undergoing meiosis. Three of the resulting four megaspores degenerate, leaving one functional megaspore. This survivor undergoes three free nuclear mitotic divisions, producing eight nuclei. These nuclei migrate towards the poles, and subsequent cell wall formation results in a seven-celled embryo sac containing the egg apparatus, polar nuclei, and three antipodal cells.

23. (4) To trap pollen grains
In a corn cob, the tassels are actually the long, silky styles and stigmas that protrude from the husk. These structures wave in the wind specifically to capture and trap airborne pollen grains released from the male flowers. This adaptation is essential for wind pollination, ensuring that the male gametes reach the female flowers located within the compact ear.

24. (3) insect pollinated plants
Plants that rely on insects for pollination have evolved specific features to attract biotic agents. Large, brightly colored petals make flowers visible from a distance, while fragrance and nectar serve as primary rewards. These floral characteristics ensure that insects visit the flowers frequently, facilitating the transfer of pollen grains between plants and promoting genetic diversity through cross-pollination.

25. (1) Synergids, zygote and primary endosperm nucleus
In a fertilized angiosperm embryo sac, different structures possess distinct ploidy levels. Synergids are haploid cells derived from the megaspore. The zygote is a diploid structure formed by the fusion of a haploid sperm with a haploid egg. The primary endosperm nucleus is triploid, resulting from the fusion of the second male gamete with two haploid polar nuclei.

26. (4) Moths and butterflies are the most dominant pollinating agents among insects.
Abiotic pollination involves wind and water, with wind being the more prevalent method. While water pollination is rare, insect-mediated pollination is highly diverse. Among various insect groups, bees are the most frequent and dominant biotic pollinators. While moths and butterflies do facilitate pollen transfer, they do not represent the primary or most common group of pollinating agents in flowering plants.

27. (1) Both Statement I and Statement II are correct
Cleistogamous flowers never open, ensuring that pollen from the anthers inevitably lands on the stigma of the same flower, making them strictly autogamous. This mechanism guarantees seed production even in the absence of external pollinators. However, it is disadvantageous because it prevents cross-pollination and genetic recombination, which can lead to inbreeding depression and reduced genetic diversity within the population.

28. (3) C → Thalamus
In the provided diagram of an apple fruit, the structure labeled as C represents the thalamus. Fruits that develop from floral parts other than the ovary, such as the receptacle or thalamus, are known as false fruits. In apples, the thalamus becomes fleshy and edible, enclosing the true fruit and seeds. This differentiates them from true fruits derived solely from ovaries.

29. (2) xenogamy
Xenogamy refers to the transfer of pollen grains from the anther of one plant to the stigma of a genetically different plant. This process is the only type of pollination that brings genetically distinct pollen to the stigma. It promotes genetic variation through cross-pollination, which is vital for the evolutionary adaptation and overall fitness of plant species in changing environments.

30. (2) 8-nucleate and 7-celled
A mature angiosperm embryo sac typically develops through three successive mitotic divisions of the functional megaspore. This results in eight nuclei. Cytokinesis then organizes these nuclei into seven distinct cells: three antipodal cells at the chalazal end, one large central cell containing two polar nuclei, and the egg apparatus at the micropylar end consisting of two synergids and one egg cell.

31. (1) Rosaceae : Leguminosae
The duration for which pollen grains remain viable after being shed from the anther varies greatly among different plant families. In many cereals like wheat and rice, pollen loses its viability within thirty minutes. However, in families such as Rosaceae, Leguminosae, and

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for developing pollen. Its cells are characterized by dense cytoplasm and frequently possess more than one nucleus. This multinucleate condition enhances the metabolic capacity and secretory activity of the tapetum, allowing it to efficiently nourish the developing microspore mother cells during their maturation process.

13. (3) A-II, B-III, C-IV, D-I
Monocot seeds possess a single large cotyledon called the scutellum. Non-albuminous seeds like groundnut lack residual endosperm at maturity. The epiblast is a small, rudimentary second cotyledon found in certain grass embryos. Perisperm represents the persistent nucellus found in specific seeds. These definitions accurately describe the structural components and variations observed in different types of angiosperm seed development.

14. (1) Nucellus
The nucellus is a central mass of parenchymatous tissue within the ovule, enclosed by the integuments. It contains abundant reserve food materials used during the development of the embryo sac. As the primary sporophytic tissue of the ovule, it provides the necessary nutrients for the functional megaspore to undergo divisions and mature into the female gametophyte structure.

15. (3) exine layer
The outer layer of the pollen grain wall, known as the exine, is composed of sporopollenin. This organic substance is exceptionally resistant to high temperatures, strong acids, alkalis, and enzymatic degradation. Because of this extreme durability, pollen grains can withstand harsh environmental conditions over geological time, allowing them to remain well-preserved as fossils within various sedimentary layers or deposits.

16. (4) B, C, D and E only
Water lily flowers emerge above the surface and are pollinated by insects or wind rather than water. In many hydrophytes, pollen grains are long and ribbon-like to aid transport. They are often protected from wetting by a mucilaginous covering. Passive transport inside water currents is common, whereas Vallisneria specifically uses surface-level pollination involving water currents to reach flowers.

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17. (1) Wind pollinated plant inflorescence showing flowers with well exposed stamens.
Wind-pollinated plants often feature compact inflorescences with numerous small flowers to maximize the chance of pollen capture. These flowers typically have well-exposed stamens that easily release pollen grains into the air. The lightweight and non-sticky nature of the pollen, combined with large, feathery stigmas, ensures efficient abiotic pollination by air currents, as seen in many common grass species.

18. (2) thalamus
In certain fruits like apples or strawberries, the fleshy part that is consumed develops from the thalamus rather than the ovary wall. These are categorized as false fruits because the floral receptacle contributes to the fruit structure. The thalamus enlarges and becomes succulent, enclosing the actual fruit or seeds, which provides a nutritional incentive for animal-mediated seed dispersal.

19. (4) D
During the germination process of a seed, different parts of the embryo develop into distinct plant organs. The radicle is the embryonic root that emerges first to establish the plant in the soil. In the provided diagram, the specific region labeled as D corresponds to the radicle, which is destined to grow and differentiate into the primary root system.

20. (4) Leguminosae, Solanaceae and Rosaceae
Pollen viability varies significantly across different plant taxa depending on environmental conditions and genetic factors. While pollen from cereals like rice and wheat loses viability within thirty minutes of release, members of the families Leguminosae, Solanaceae, and Rosaceae exhibit much longer viability. In these specific families, pollen grains can remain functional and capable of fertilization for several months.

21. (1) geitonogamy
Geitonogamy is the transfer of pollen grains from the anther to the stigma of another flower on the same individual plant. Although it often requires a pollinating agent and is functionally a type of cross-pollination, it is genetically identical to autogamy. This is because all flowers on a single plant share the same genetic makeup, resulting in self-fertilization progeny.

41. (4) Sporopollenin
Sporopollenin is one of the most resistant organic materials known in the biological world. It forms the outer layer of the pollen grain wall, the exine. This substance can withstand high temperatures, strong acids, and alkalis, and is not degraded by any known enzymes. This exceptional durability allows pollen grains to survive harsh conditions and persist in the fossil record for millions of years.

42. (4) Pinus.
In certain gymnosperms like Pinus, the pollen grains possess two wing-like structures formed by the extension of the exine layer. these wings increase the surface area and buoyancy of the pollen grains, facilitating their dispersal by wind over long distances. This adaptation is a key feature of anemophilous plants, ensuring that pollen reaches female cones efficiently across diverse forest environments.

43. (4) syngamy and triple fusion.
Double fertilization is a characteristic process unique to angiosperms. It involves two distinct fusion events within the embryo sac. Syngamy occurs when one male gamete fuses with the egg cell to form a diploid zygote. Triple fusion occurs when the second male gamete fuses with the two polar nuclei in the central cell, resulting in a triploid primary endosperm nucleus.

44. (2) embryo sac
In the process of megasporogenesis, a megaspore mother cell undergoes meiosis to produce four haploid megaspores. Generally, three of these degenerate, and the single functional megaspore continues to develop. This functional megaspore undergoes successive mitotic divisions to form the mature female gametophyte, also known as the embryo sac, which contains the egg apparatus, polar nuclei, and antipodal cells.

45. (1) entomophily
Entomophily refers to the pollination of flowers by insects. To ensure repeated visits by pollinators, entomophilous plants have evolved various attractants, such as large, colorful petals and fragrant scents. Additionally, they provide rewards like nutrient-rich pollen and energy-dense nectar. These features are essential for biotic pollination, whereas abiotic methods like wind or water pollination do not require such specialized floral adaptations.

46. (2) wind
Flowers adapted for wind pollination, or anemophily, often exhibit specific structural traits. These typically include ovaries containing a single ovule and multiple small flowers packed into compact inflorescences. This arrangement increases the likelihood of capturing airborne pollen. Unlike insect-pollinated plants, these flowers are usually non-showy and lack nectar, as they do not need to attract animal vectors for reproduction.

47. (1) autogamy and geitonogamy
A dioecious plant species produces male and female flowers on separate individual plants. Because the different sexes are physically isolated on different individuals, autogamy and geitonogamy are both impossible. Autogamy requires the same flower, and geitonogamy requires the same plant. Therefore, dioecious plants rely exclusively on xenogamy, which involves the transfer of pollen between flowers on different individual plants.

48. (3) angiosperms
Double fertilization is a complex and unique reproductive mechanism found exclusively in flowering plants, known as angiosperms. It involves two simultaneous fertilization events: one male gamete fuses with the egg to form a zygote, while another fuses with the two polar nuclei to create the endosperm. This process is not found in algae, fungi, or gymnosperms, making it a defining characteristic of angiospermae.

49. (3) reduction division occurs in the megaspore mother cells
In the majority of angiosperms, the reproductive process involves a reduction division, or meiosis, in the megaspore mother cell. This division produces four haploid megaspores, facilitating the alternation of generations from sporophyte to gametophyte. While the filiform apparatus is in synergids rather than the egg, and the central cell is large, the occurrence of meiosis is a universal and essential event.

50. (2) insects or wind
Despite being aquatic, plants like water hyacinth and water lily produce flowers that are held well above the water level. This positioning makes them accessible to terrestrial pollination agents. Consequently, these species are typically pollinated by insects or wind rather than by

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Solanaceae, pollen grains can maintain their functional ability to fertilize an egg for several months under favorable conditions.

32. (4) (1) and (4).
In seed plants, certain structures uniquely contain two distinct generations. An anther contains pollen grains, where the anther represents the diploid sporophyte and the pollen grain represents the haploid gametophyte. Similarly, an ovule houses the embryo sac, representing the haploid gametophyte generation developing within the tissues of the diploid sporophyte generation. These examples illustrate the alternation of generations in angiosperms.

33. (1) insects or wind
Although water hyacinth and water lily are aquatic plants, they do not utilize water as a medium for pollination. Instead, their flowers emerge above the water surface to be accessible to terrestrial agents. Depending on the species and environmental factors, these plants are typically pollinated by insects or wind, similar to the majority of terrestrial flowering plants found in their ecosystems.

34. (2) Monosporic with three sequential mitotic divisions
The most common type of embryo sac development in angiosperms is known as the Polygonum type. This process is monosporic, meaning it starts with a single functional megaspore. This megaspore undergoes three successive rounds of free nuclear mitotic divisions to produce eight nuclei, which are then organized into the characteristic seven-celled, eight-nucleate structure of the mature female gametophyte.

35. (4) Male flowers are carried by water currents to female flowers at surface of water.
In the aquatic plant Vallisneria, pollination occurs at the water surface. The female flower reaches the surface by a long stalk, while male flowers or pollen grains are released onto the surface and carried passively by water currents. Some of these male gametes eventually reach the female flowers, facilitating pollination through the medium of water in a specialized surface-level mechanism.

36. (2) Papaya
In dioecious plants like papaya, male and female flowers are produced on separate individuals. This condition effectively prevents both autogamy, which is pollination within the same flower, and geitonogamy, which is pollination between different flowers of the same plant. Consequently, such plants rely exclusively on xenogamy, or cross-pollination, ensuring maximum genetic diversity and preventing the negative effects of self-fertilization.

37. (1) One fuses with the egg and other fuses with central cell nuclei.
Upon reaching the embryo sac, the pollen tube discharges two male gametes into a synergid. One gamete moves toward the egg cell and fuses with its nucleus to form a diploid zygote through syngamy. The other male gamete moves toward the central cell and fuses with the two polar nuclei to form the triploid primary endosperm nucleus through triple fusion.

38. (3) perisperm
In most angiosperm seeds, the nucellus is completely consumed during the development of the embryo and endosperm. However, in certain species like black pepper and beet, remnants of the nucellus persist as a distinct layer of nutritive tissue. This persistent nucellar tissue is technically referred to as the perisperm and serves as an additional source of nutrients for the germinating embryo.

39. (1) Ovules develop into embryo sac.
Following fertilization, several transformations occur within the floral organs. The ovary matures into a fruit, and the zygote develops into a multi-cellular embryo. The central cell, containing the primary endosperm nucleus, develops into the endosperm tissue. However, ovules do not develop into embryo sacs; rather, the embryo sac exists within the ovule, and the entire ovule matures into a seed.

40. (3) -196°C
Cryopreservation is a technique used to store biological materials at extremely low temperatures to maintain their viability over long periods. Pollen grains from many plant species can be successfully stored for several years in liquid nitrogen at -196 degrees Celsius. This method is widely utilized in plant breeding programs and germplasm banks to preserve genetic diversity and facilitate controlled hybridization across seasons.

NODIA

60. (4) Nectar and pollen grains
Flowers that rely on animals for pollination provide specific rewards to ensure the pollinators return. The most common and important rewards are nectar, which provides a high-energy sugar source, and pollen grains, which are rich in protein. These nutritional incentives encourage animals, such as insects and birds, to visit multiple flowers, thereby facilitating the effective transfer of pollen across different plants.

61. (3) Geitonogamy
Geitonogamy is the transfer of pollen grains from the anther to the stigma of another flower on the same plant. While it often requires external pollinators like insects or wind, making it functionally similar to cross-pollination, it is genetically identical to autogamy. This is because all flowers on a single plant possess the same genetic makeup, resulting in self-fertilization at the genetic level.

62. (2) Honey is made by bees by digesting pollen collected from flowers.
Bees produce honey by collecting nectar from flowers, not by digesting pollen. The nectar is processed through regurgitation and evaporation within the hive to create honey. While bees do collect pollen as a protein source for their larvae, it is not the ingredient for honey. Other statements about floral odors, pollen nutrients, and pollen allergies are biologically accurate.

63. (3) seed, where funicle was attached
The hilum is a visible scar on the seed coat that represents the point of attachment between the seed and the funicle, which is the stalk of the ovule. It serves as a permanent mark of where the developing seed was connected to the maternal placental tissue within the ovary. The micropyle is usually located as a small pore near this hilum.

64. (4) solid style.
Transmission tissue is a specialized internal tissue found in plants with solid styles. It consists of cells with thin walls and abundant intercellular spaces, often containing mucilage. This tissue provides a pathway and nutritional support for the growth of pollen tubes as they travel from the stigma through the style toward the ovules. In contrast, hollow styles have an open canal.

65. (4) free nuclear endosperm.
The fluid inside a tender coconut is formed through a process where the primary endosperm nucleus undergoes multiple rounds of nuclear division without immediate cell wall formation. This results in a liquid containing thousands of free-floating nuclei, known as free nuclear endosperm. This liquid provides nutrients for the developing embryo and eventually partially solidifies into the white coconut meat or cellular endosperm.

66. (2) banana
Parthenocarpy is the development of fruit without the process of fertilization, resulting in seedless fruits. Banana is a classic example of a naturally parthenocarpic fruit. While fruits like apples are considered false fruits because they develop from the thalamus, parthenocarpic fruits are defined by their lack of seeds and their development independent of the normal sexual reproduction process in flowering plants.

67. (1) fertilisation of a flower by the pollen from another flower of the same plant
Geitonogamy is a specific type of pollination where pollen is transferred from the anther of one flower to the stigma of a different flower located on the same individual plant. Although this process often utilizes external pollinators and resembles cross-pollination, it is genetically a form of self-pollination. This is because all flowers on the same plant are genetically identical to one another.

68. (3) supplementing food
Pollen grains are highly nutritious, containing significant amounts of proteins, carbohydrates, and vitamins. In many Western countries, pollen products, including tablets and syrups, are commercially available as food supplements. These products are often consumed by athletes and individuals seeking to enhance performance or general health, as pollen is believed to provide a concentrated source of natural energy and essential nutrients.

69. (4) guide the entry of pollen tube.
The filiform apparatus consists of specialized finger-like projections of the cell wall located at the micropylar end of the synergids. Its primary biological function is to secrete chemical attractants that guide the pollen tube's growth toward the embryo sac. By directing the pollen

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water currents. This strategy is common among many aquatic angiosperms that have adapted to utilize biotic or atmospheric abiotic vectors.

51. (1) megasporangium
In the reproductive morphology of angiosperms, the ovule is the structure that houses the female gametophyte and eventually develops into a seed. Anatomically and functionally, the ovule is considered equivalent to the megasporangium. Within this megasporangium, megasporogenesis occurs, leading to the formation of megaspores, one of which will develop into the mature embryo sac where fertilization eventually takes place.

52. (3) Tapetum helps in the dehispence of anther.
The tapetum is the innermost layer of the anther wall and is primarily responsible for providing nutrition to developing microspores. It does not play a role in anther dehiscence. Instead, the endothecium layer is responsible for the mechanical opening of the anther. Other facts, such as sporopollenin in the exine and pollen storage in liquid nitrogen, are correct biological observations.

53. (3) Pollen grains of many species can germinate on the stigma of a flower, but only one pollen tube of the same species grows into the style.
While multiple pollen grains from the same species often germinate on a compatible stigma, multiple pollen tubes of the same species can grow into the style. Frequently, multiple tubes grow through the style, although typically only one successfully fertilizes the egg within an individual ovule. Pollen-pistil interactions are highly selective chemical processes that determine compatibility and regulate the growth of these tubes.

54. (2) thalamus or petal
A typical stamen consists of a long, slender stalk called the filament and a terminal structure called the anther. The proximal end of the filament is the part attached to the base of the flower. This attachment usually occurs on the thalamus, which is the floral receptacle, or sometimes to the petals, a condition known as epipetalous in many plant families.

55. (2) free nuclear endosperm
The liquid found inside a tender coconut is a classic example of free nuclear endosperm. During its development, the primary endosperm nucleus undergoes successive nuclear divisions without immediate cell wall formation, resulting in a liquid containing thousands of free nuclei. As the fruit matures, peripheral cells begin forming walls, eventually creating the solid white cellular endosperm known as the coconut meat.

56. (2) apomixis
Apomixis is a specialized form of asexual reproduction in flowering plants that mimics sexual reproduction by producing seeds without fertilization. This process allows plants to produce offspring that are genetically identical to the parent. It is particularly important in agriculture for maintaining hybrid vigor across generations, as it bypasses the genetic recombination and segregation that occur during normal sexual seed formation.

57. (2) synergids
The filiform apparatus is a specialized, finger-like cellular thickening located at the micropylar end of the synergid cells within the embryo sac. Its primary function is to guide the entry of the pollen tube into the synergid by secreting chemotropic substances. This structure is a critical component of the egg apparatus, ensuring that male gametes are successfully delivered for the fertilization process.

58. (1) involve meiosis
Microsporogenesis and megasporogenesis are the processes of forming microspores and megaspores, respectively. Both processes involve a reductional division, or meiosis, where a diploid mother cell produces haploid spores. Microsporogenesis occurs in the anthers, while megasporogenesis occurs within the ovules. These spores then undergo mitotic divisions to develop into the male and female gametophytes, eventually producing the gametes necessary for sexual reproduction.

59. (3) two sperms and a vegetative cell
The male gametophyte of angiosperms, commonly known as the pollen grain, undergoes mitotic divisions to produce three distinct cells. These include one large vegetative cell, which facilitates pollen tube growth, and two smaller male gametes or sperms. These two sperms are essential for the process of double fertilization, where they fuse with the egg and central nuclei within the mature embryo sac.

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1993

132. Study of formation, growth and development of new individual from an egg is
(1) apomixis
(2) embryology
(3) embryogeny
(4) cytology.

1992

133. Meiosis is best observed in dividing
(1) cells of apical meristem
(2) cells of lateral meristem
(3) microspores and anther wall
(4) microsporocytes.

1991

134. Point out the odd one.
(1) Nucellus
(2) Embryo sac
(3) Micropyle
(4) Pollen grain

1991

135. Pollination occurs in
(1) bryophytes and angiosperms
(2) pteridophytes and angiosperms
(3) angiosperms and gymnosperms
(4) angiosperms and fungi.

1991

136. Double fertilisation is fusion of
(1) two eggs
(2) two eggs and polar nuclei with pollen nuclei
(3) one male gamete with egg and other with synergid
(4) one male gamete with egg and other with secondary nucleus.

1991

137. Syngamy means
(1) fusion of gametes
(2) fusion of cytoplasms
(3) fusion of two similar spores
(4) fusion of two dissimilar spores.

1991

138. Which of the following pair have haploid structures?
(1) Nucellus and antipodal cells
(2) Antipodal cells and egg cell
(3) Antipodal cells and megaspore mother cell
(4) Nucellus and primary endosperm nucleus

1991

139. Embryo sac occurs in
(1) embryo
(2) axis part of embryo
(3) ovule
(4) endosperm.

1990

140. Entry of pollen tube through micropyle is
(1) chalazogamy
(2) mesogamy
(3) porogamy
(4) pseudogamy.

1990

141. Female gametophyte of angiosperms is represented by
(1) ovule
(2) megaspore mother cell
(3) embryo sac
(4) nucellus.

1990

142. Male gametophyte of angiosperms/monocots is
(1) microsporangium
(2) nucellus
(3) microspore
(4) stamen.

1990

143. Tegmen develops from
(1) funiculus
(2) chalaza
(3) inner integument
(4) outer integument.

1989

144. Which is correct?
(1) Gametes are invariably haploid.
(2) Spores are invariably haploid.
(3) Gametes are generally haploid.
(4) Both spores and gametes are invariably haploid.

1989

145. Generative cell was destroyed by laser but a normal pollen tube was still formed because
(1) vegetative cell is not damaged
(2) contents of killed generative cell stimulate pollen growth
(3) laser beam stimulates growth of pollen tube
(4) the region of emergence of pollen tube is not harmed.

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1989, 1988

146. Perisperm is
(1) remnant of endosperm
(2) persistent nucellus
(3) peripheral part of endosperm
(4) disintegrated secondary nucleus.

tube into one of the synergids, the filiform apparatus ensures the successful delivery of male gametes for fertilization.

70. (4) pea.
Non-albuminous or exalbuminous seeds are those in which the endosperm is completely consumed by the developing embryo before the seed reaches maturity. In these seeds, food is typically stored in the cotyledons. Examples include legumes like peas, beans, and groundnuts. In contrast, albuminous seeds, such as maize, wheat, and castor, retain a portion of the endosperm as a separate food storage tissue.

71. (1) no dependence on pollinators
Cleistogamous flowers are those that never open, ensuring that pollination occurs exclusively within the closed bud. This mechanism provides a significant advantage by guaranteeing seed set even in environmental conditions where external pollinating agents, such as insects or wind, are scarce or absent. While it limits genetic variation, it ensures reproductive success and the preservation of parental traits in stable environments.

72. (2) ovule
In the terminology of plant reproduction, the ovule is functionally and structurally equivalent to the megasporangium. It is the site where megasporogenesis occurs, leading to the formation of megaspores. One of these megaspores eventually develops into the female gametophyte or embryo sac. After fertilization, the entire ovule matures into a seed, which contains the embryo and necessary food reserves for germination.

73. (2) Tapetum nourishes the developing pollen.
The tapetum is the innermost layer of the anther wall and plays a crucial role in providing essential nutrients to the developing microspores or pollen grains. It is highly active metabolically. In contrast, the endothecium aids in dehiscence, the outer hard layer of pollen is the exine made of sporopollenin, and sporogenous tissue is diploid, undergoing meiosis to produce haploid microspores.

74. (3) cucumber
Pollination in cucumber plants typically requires animal vectors, primarily insects like bees, to transfer pollen from male to female flowers. This is common in many members of the Cucurbitaceae family. In contrast, Vallisneria uses water currents for pollination, while maize and mulberry are primarily wind-pollinated. These different mechanisms reflect the diverse adaptations plants have evolved to ensure successful gamete transfer and reproduction.

75. (4) meiotic division.
Megaspores are formed within the ovule from a specialized diploid cell called the megaspore mother cell. This cell undergoes a single meiotic division, which is a reductional division, to produce a linear tetrad of four haploid megaspores. This process, known as megasporogenesis, is essential for transitioning from the diploid sporophytic generation to the haploid gametophytic generation in the life cycle of angiosperms.

76. (1) Cleistogamous flowers are always autogamous.
Cleistogamous flowers remain permanently closed, meaning that the pollen grains from the anthers can only reach the stigma of the very same flower. This makes them invariably autogamous. Other statements are incorrect: xenogamy can occur via various agents, chasmogamous flowers do open at maturity, and geitonogamy involves flowers on the same plant, rather than different individual plants of the same species.

77. (3) Sporopollenin can withstand high temperatures as well as strong acids and alkalis.
Sporopollenin is an extraordinarily durable organic polymer that constitutes the exine, or outer layer, of the pollen grain wall. It is renowned for its ability to resist degradation by high temperatures, strong acids, and concentrated alkalis. Furthermore, no enzyme is currently known that can break down sporopollenin. This chemical resilience is why pollen grains are so well-preserved in the fossil record.

78. (4) coconut.
In most seeds, the seed coat is a relatively thin and protective layer. However, in the coconut, the seed is enclosed by a very thick and hard endocarp, often referred to as the shell. This structure is not a thin membranous coat like those found in groundnut, gram, or maize. The coconut's specialized anatomy provides significant protection for the embryo and large endosperm during dispersal.

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98. (4) Egg cell and antipodal cells
In the life cycle of angiosperms, the cells within the mature embryo sac are haploid because they develop from a haploid megaspore through mitotic divisions. Specifically, the egg cell and the three antipodal cells contain only one set of chromosomes. In contrast, tissues like the nucellus and megaspore mother cell are diploid sporophytic structures, and the secondary nucleus is typically diploid or dikaryotic.

99. (3) It helps in the entry of pollen tube into a synergid.
The filiform apparatus is a specialized, thickened wall structure found at the micropylar end of the synergid cells within the embryo sac. Its primary role is to guide the growing pollen tube toward the egg apparatus by secreting chemotropic substances. This guidance ensures that the pollen tube enters one of the synergids correctly to release the male gametes for fertilization.

100. (3) autogamy, but not geitonogamy
When flowers are unisexual, meaning they are either exclusively male or exclusively female, autogamy is impossible because the same flower lacks both reproductive organs. However, if male and female flowers are present on the same plant, geitonogamy can still occur through the transfer of pollen between them. To prevent geitonogamy as well, a plant must be dioecious, with sexes on separate individuals.

101. (1) Pollen exine
The outer wall of a pollen grain, known as the exine, is composed of sporopollenin. This substance is one of the most chemically resistant organic materials found in nature. It is highly resistant to degradation by strong acids, concentrated alkalis, and high temperatures. Furthermore, no biological enzyme has been discovered that can break down sporopollenin, making the pollen exine extremely durable.

102. (1) generative cell
During the development of the male gametophyte in angiosperms, the microspore undergoes an asymmetric mitotic division to form a large vegetative cell and a smaller generative cell. The generative cell eventually divides again through mitosis to produce two haploid male gametes. This second division can occur either within the pollen grain before it is shed or within the growing pollen tube during germination.

103. (4) Microspore mother cell
During microsporogenesis, the diploid microspore mother cells are characterized by the development of a thick callose wall. This internal layer of callose isolates the mother cells from each other, facilitating the meiotic division process. After meiosis, the resulting tetrad of four haploid microspores remains enclosed within this callose wall until it is eventually degraded by the enzyme callase, released by the tapetum.

104. (4) can reproduce freely with each other and form seeds.
In the biological species concept, the most definitive criterion for identifying members of the same species is their ability to interbreed under natural conditions and produce fertile offspring. While genetic similarity and physical appearance provide useful information, the fundamental biological boundary of a species is reproductive isolation. Therefore, plants that can freely reproduce and generate viable seeds are considered to belong to the same species.

105. (3) 3 + 2 + 3
A typical mature embryo sac in many dicot plants follows the Polygonum pattern of development. This results in an eight-nucleate structure where three nuclei are located in the egg apparatus at the micropylar end, two nuclei remain as polar nuclei in the large central cell, and three nuclei form the antipodal cells at the chalazal end, following the 3+2+3 arrangement.

106. (3) scutellum
In the seeds of cereals and other grasses, the single large cotyledon of the embryo is called the scutellum. It is positioned laterally to the embryonal axis. The primary function of the scutellum is to absorb nutrients from the endosperm and transfer them to the developing embryo during germination. It is a specialized structure characteristic of monocotyledonous seeds in the Poaceae family.

107. (1) Amphitropous
An amphitropous ovule is characterized by a significant curvature that affects both the ovule body and the embryo sac itself. This results in the embryo sac assuming a distinct horse-shoe shape. In this orientation, the micropyle and the funiculus are brought into close proximity to each other. This specialized structural arrangement is

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apparatus plays a vital role in the fertilization process by secreting chemotropic substances that guide the growing pollen tube into the synergid for gamete release.

89. (4) Cleistogamy
Cleistogamy involves flowers that never open, ensuring that the reproductive organs are always enclosed. This condition forces the pollen from the anthers to land on the stigma of the same flower, resulting in mandatory autogamy. In contrast, chasmogamy involves flowers that open, allowing for potential cross-pollination. Geitonogamy and xenogamy are different types of pollination involving different flowers or plants entirely.

90. (3) grasses
Wind pollination, or anemophily, is a common reproductive strategy found in many plant groups, but it is particularly prevalent among grasses. Grass flowers are typically small, inconspicuous, and lack nectar or scent since they do not need to attract animal pollinators. They produce large quantities of lightweight, non-sticky pollen and often have feathery stigmas to effectively capture airborne grains from the environment.

91. (1) embryo sac
In the process of megasporogenesis, a diploid megaspore mother cell undergoes meiosis to produce four haploid megaspores. Usually, three of these degenerate, and the remaining functional megaspore undergoes three successive mitotic divisions. This development leads to the formation of the mature female gametophyte, which is technically called the embryo sac, containing the egg cell, synergids, antipodals, and polar nuclei.

92. (1) Citrus
Nucellar polyembryony is a phenomenon where embryos develop directly from the diploid nucellar cells surrounding the embryo sac, in addition to the zygotic embryo. This results in multiple embryos within a single seed, which are genetically identical to the parent plant. This condition is frequently reported and commonly observed in various species of the genus Citrus and also in mango plants.

93. (4) Both produce progeny identical to the parent.
Vegetative reproduction and apomixis are both forms of asexual reproduction. Vegetative reproduction involves growth from specialized plant parts, while apomixis involves seed production without fertilization. Because neither process involves the fusion of gametes or genetic recombination, the resulting offspring are clones that are genetically identical to the parent plant. This allows for the consistent propagation of desirable traits in various plant species.

94. (2) geitonogamy
Geitonogamy is defined as the transfer of pollen grains from the anther of one flower to the stigma of another flower on the same individual plant. Although this process often requires a pollinator and is functionally similar to cross-pollination, it is genetically equivalent to autogamy. This is because all the flowers on a single plant share an identical genetic constitution.

95. (2) small, producing large number of dry pollen grains
Flowers adapted for wind pollination typically have specific traits to facilitate abiotic pollen transfer. They are generally small and lack bright colors or nectar. To maximize the chance of successful pollination by air currents, these flowers produce vast quantities of lightweight, non-sticky, and dry pollen grains. This strategy compensates for the random nature of wind-mediated transport and ensures reproductive success.

96. (3) A: Offset, B: Antheridiophore, C: Antipodals, D: Oogonium
In botanical morphology and life cycles, an offset is a lateral branch used for vegetative propagation in aquatic plants like Eichhornia. An antheridiophore is a specialized structure in liverworts that bears male reproductive organs. Within the mature embryo sac of angiosperms, antipodals are the three cells located at the chalazal end. An oogonium is the female sex organ found in various algae and fungi.

97. (2) maternal sporophytic tissue in ovule
In Citrus species, apomictic embryos frequently arise from the diploid cells of the nucellus or integuments, which are maternal sporophytic tissues. These cells begin to divide and protrude into the embryo sac, where they develop into embryos without undergoing fertilization. This process, known as adventive embryony, results in multiple embryos that are genetically identical to the mother plant within a single seed.

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CHAPTER 21
Human Reproduction

2026 (RE-NEET)

1. Sperm motility is due to ___.
(1) amoeboid movement
(2) muscular movement
(3) flagellar movement
(4) ciliary movement

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2. Which structure is not a part of the male reproductive system?
(1) Vasa efferentia
(2) Infundibulum
(3) Rete testis
(4) Epididymis

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3. Which of the following hormone is not secreted by human placenta?
(1) Progesterone
(2) LH
(3) hCG
(4) Estrogen

2026 (RE-NEET)

4. The covering of ovum at ovulation is ___.
(1) zona pellucida
(2) chorion
(3) endometrium
(4) zona radiata

2026 (RE-NEET)

5. Given below are two statements:
Statement I: Ovulation is caused by LH surge leading to rupture of Graafian follicles.
Statement II: Graafian follicle remaining after ovulation transforms into corpus luteum and secretes large amount of estrogen.
(1) Statement I is correct but Statement II is incorrect
(2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Both Statement I and Statement II are incorrect

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2026 (CANCELLED)

6. Spermatogonia undergo a series of cell divisions to produce sperms. Select the correct statements from the following:
A. Spermatogonia always undergo meiotic cell division.
B. Primary spermatocytes divide mitotically to produce secondary spermatocytes.
C. Secondary spermatocytes, through their second meiotic division, produce haploid spermatids.
D. Spermatids produce spermatozoa through mitosis.
E. Spermatids transform into spermatozoa by spermiogenesis.
Choose the correct answer from the options given below:
(1) A and E only
(2) C and E only
(3) A, C and E only
(4) B, C and D only

2026 (CANCELLED)

7. Match List I with List II related to embryonic development at various months of pregnancy:
List I:
A. The foetus movement starts and hair appears on the head
B. The foetus develops limbs and digits
C. The foetus develops external genital organs
D. The foetus body is covered with fine hair; eyelids separate and eyelashes are formed
List II:
I. 24 weeks of pregnancy
II. 20 weeks of pregnancy
III. 8 weeks of pregnancy
IV. 12 weeks of pregnancy
Choose the correct answer from the options given below:
(1) A-IV, B-II, C-III, D-I
(2) A-II, B-III, C-IV, D-I
(3) A-III, B-II, C-IV, D-I
(4) A-II, B-IV, C-III, D-I

observed in certain plant families, such as the Alismataceae and Butomaceae.

108. (3) Degenerated synergids
During the process of fertilization in angiosperms, the pollen tube enters the embryo sac through the micropylar end. It specifically penetrates one of the two synergids. Prior to or during the entry of the pollen tube, this synergid typically begins to degenerate. The male gametes are then discharged into the cytoplasm of the degenerated synergid, from where they migrate toward the egg and central cell.

109. (1) nucellus or integuments
Adventive embryony is a form of apomixis where embryos develop directly from diploid sporophytic cells outside the embryo sac, specifically from the nucellus or the integuments. These cells undergo mitotic divisions and eventually protrude into the embryo sac to function as additional embryos. This process bypasses meiosis and fertilization, resulting in offspring that are genetically identical to the maternal plant.

110. (1) hemitropous
A hemitropous ovule is characterized by a structure where the body of the ovule is turned at a ninety-degree angle relative to the funicle. In this arrangement, the nucellus and the embryo sac lie horizontally and at a right angle to the stalk or funicle. This orientation is distinct from other types like anatropous or orthotropous, where the alignments are vertical.

111. (4) opening of flower bud.
Anthesis is a botanical term that refers specifically to the period during which a flower is fully open and functional. It marks the transition from a developing floral bud to a mature flower ready for pollination. During anthesis, the petals expand, and the reproductive organs, including the anthers and stigma, become exposed to potential pollinators or environmental agents like wind and water.

112. (2) both wall and the sporogenous cells
In the development of the microsporangium, the archesporium is a specialized group of cells that undergoes a periclinal division. This division results in an outer primary parietal layer and an inner primary sporogenous layer. The parietal layer eventually develops into the various wall layers of the anther, while the sporogenous layer gives rise to the microspore mother cells through further divisions.

113. (2) callose
During microsporogenesis, the microspore mother cell is surrounded by a layer of callose. Following meiotic division, the four resulting haploid microspores remain held together in a tetrad, completely encased by this shared callose wall. The tapetum later secretes an enzyme called callase, which dissolves this layer, allowing the individual microspores to separate and mature into pollen grains with their own walls.

114. (2) Downward
An anatropous ovule is the most common type found in angiosperms and is characterized by a complete 180-degree inversion. In this inverted position, the body of the ovule is fused with the funicle along one side, and the micropyle is situated at the bottom, pointing downward and located very close to the hilum. This orientation facilitates the entry of the pollen tube.

115. (4) synergids.
In angiosperms, the pollen tube travels through the style and enters the ovule through the micropyle. Upon reaching the mature embryo sac, the tube penetrates one of the two synergid cells. Once inside the synergid, the tip of the pollen tube ruptures, liberating the two male gametes into the synergid's cytoplasm, from where they move to complete the process of fertilization.

116. (1) One meiotic and two mitotic divisions
For the formation of mature pollen grains, a microspore mother cell first undergoes one meiotic division to produce four haploid microspores. Each individual microspore then undergoes its first mitosis to form a vegetative cell and a generative cell. Subsequently, the generative cell undergoes a second mitotic division to produce two male gametes, resulting in a mature, three-celled male gametophyte ready for fertilization.

117. (4) coconut.
Anemophily, or pollination by wind, is common in many plants, including members of the palm family like coconut. Coconut flowers are small and produce large quantities of lightweight pollen suited for wind dispersal. In contrast, Salvia and Bottlebrush are primarily insect and bird pollinated, respectively, while Vallisneria is

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a well-known example of hydrophily, using water currents to facilitate the transfer of its pollen.

118. (1) nucellus
In Citrus plants, adventive embryony is a form of polyembryony where embryos develop from the diploid sporophytic cells of the nucellus. These nucellar cells surrounding the embryo sac begin to divide and protrude into the sac, where they develop into mature embryos alongside the zygotic embryo. This asexual process ensures that the resulting nucellar embryos are genetically identical to the parent plant.

119. (4) any of these.
An eight-nucleated embryo sac is the standard mature structure for the majority of angiosperms. This configuration can develop through different pathways: monosporic, where it originates from one megaspore; bisporic, from two megaspores; or tetrasporic, where all four megaspore nuclei contribute. regardless of the number of megaspores involved in its initiation, the resulting mature embryo sac typically contains eight nuclei.

120. (1) two polar nuclei and one male gamete
During the process of double fertilization, a triploid endosperm tissue is formed through triple fusion. This event occurs when one of the two haploid male gametes delivered by the pollen tube fuses with the two haploid polar nuclei located in the large central cell of the embryo sac. This resulting triploid cell subsequently divides to form the endosperm, which provides nourishment.

121. (3) endosperm
In angiosperms, double fertilization is a unique process involving two distinct fusion events. While one fusion produces the zygote, the second fusion, known as triple fusion, involves a male gamete and two polar nuclei. This specific role of double fertilization is to initiate the development of the triploid endosperm, which serves as a vital nutritive tissue for the developing embryo within the seed.

122. (1) two cotyledons
Sunflower, or Helianthus annuus, belongs to the family Asteraceae, which is a group of dicotyledonous flowering plants. As a dicot, the sunflower embryo typically develops with two distinct seed leaves, known as cotyledons. These cotyledons often serve as food storage organs or become photosynthetic during the early stages of germination, providing the young seedling with the necessary energy to establish itself.

123. (1) 16
In the process of microsporogenesis, each microspore mother cell undergoes a single meiotic division to produce a tetrad consisting of four haploid microspores. Each of these microspores subsequently develops into an individual pollen grain. Therefore, if an anther contains four microspore mother cells, the total number of pollen grains produced will be sixteen, as each cell yields four functional grains.

124. (2) opening of flower bud
Anthesis describes the developmental stage when a flower bud expands and opens to expose its reproductive structures. This process is synchronized with the maturation of pollen and the receptivity of the stigma, ensuring that the flower is ready for pollination. It is a critical event in the life cycle of plants, signaling the beginning of the functional reproductive phase for each individual flower.

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125. (3) 25
In angiosperms, microspores are produced from microspore mother cells through the process of meiosis. One diploid microspore mother cell undergoes a single meiotic division to produce a tetrad of four haploid microspores, each of which matures into a pollen grain. Therefore, to obtain one hundred pollen grains, twenty-five microspore mother cells must undergo meiosis, as each cell produces four grains.

126. (3) Citrus
Polyembryony is the condition where a single seed contains more than one embryo. This phenomenon is particularly common in the genus Citrus. In these plants, additional embryos often arise from the diploid sporophytic cells of the nucellus or integuments, alongside the normally developed zygotic embryo. This results in the formation of multiple seedlings from a single seed, most of which are clones.

127. (2) geitonogamy
Geitonogamy is the specific mode of pollination where pollen is transferred from the anther to the stigma of a different flower on the same plant. Although this process often requires a pollinator

and is functionally similar to cross-pollination, it is genetically equivalent to autogamy. This is because all flowers on a single plant are derived from the same genetic stock and are identical.

128. (2) megagametophyte
In the life cycle of angiosperms, the embryo sac is the structure that contains the female gametes and is derived from a haploid megaspore. Therefore, the embryo sac represents the megagametophyte generation. It typically consists of seven cells and eight nuclei, including the egg cell, which is the actual female gamete. This generation is highly reduced and dependent on the sporophyte for nutrition.

129. (4) 250/500.
To produce a single pea seed, one meiotic division is required in the microspore mother cell to yield pollen and one in the megaspore mother cell to yield an egg. Thus, for two hundred seeds, two hundred divisions are needed for eggs and fifty for pollen, totaling two hundred fifty. For four hundred seeds, five hundred divisions are required in total.

130. (1) orthotropous
An orthotropous ovule is the simplest and most primitive type found in certain plants like Piper and Polygonum. In this orientation, the ovule is completely straight, such that the micropyle, the chalaza, and the funicle are all perfectly aligned along a single vertical axis. There is no curvature or inversion, making the chalazal and micropylar ends lie at opposite poles in a straight line.

131. (1) angiosperms
Double fertilization is a highly specialized and complex reproductive process that is a unique characteristic of all angiosperms, or flowering plants. It involves two separate fusion events: one male gamete fuses with the egg to form a diploid zygote, while the second fuses with the polar nuclei to form the triploid endosperm. This mechanism is absent in other groups like gymnosperms and bryophytes.

132. (2) embryology
Embryology is the branch of biological science that focuses on the study of the formation, growth, and development of a new individual from a fertilized egg or zygote. It encompasses all the stages of development from the initial fertilization event through the complex processes of cell division, differentiation, and organogenesis that eventually result in a fully formed embryo capable of independent survival.

133. (4) microsporocytes.
Meiosis is the specialized reductional division required to produce haploid spores or gametes from diploid cells. In plants, this process is most easily and clearly observed in microsporocytes, also known as microspore mother cells, located within the anther. These cells are actively dividing during the formation of microspores, making them ideal subjects for studying the different stages of meiotic chromosome behavior.

134. (4) Pollen grain
In the context of female reproductive structures in plants, the nucellus, embryo sac, and micropyle are all integral components of the ovule. They work together to facilitate the development of the female gametophyte and subsequent fertilization. The pollen grain, however, is the male gametophyte and belongs to the male reproductive system, making it the odd structure in this specific group.

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135. (3) angiosperms and gymnosperms
Pollination is the process of transferring pollen grains from the male reproductive structures to the female reproductive structures. This phenomenon is a fundamental requirement for sexual reproduction in all seed-bearing plants, which include both angiosperms and gymnosperms. In contrast, lower plants like bryophytes and pteridophytes do not produce pollen and instead rely on water for the movement of motile flagellated sperm cells.

136. (4) one male gamete with egg and other with secondary nucleus.
Double fertilization is a unique process in angiosperms where two separate fusions occur within the embryo sac. One male gamete fuses with the egg cell to form a diploid zygote, a process called syngamy. The second male gamete fuses with the two polar nuclei or the secondary nucleus to form the triploid primary endosperm nucleus, termed triple fusion.

137. (1) fusion of gametes
Syngamy is the fundamental biological process of sexual reproduction where two haploid gametes, typically a sperm and an egg, fuse together. This fusion results in the formation of a single diploid

79. (1) being a diploid tissue
Perisperm is the persistent part of the nucellus that remains in the seed after development, and because it is derived directly from the parental sporophyte, it is a diploid tissue. In contrast, the endosperm is a triploid tissue formed by the fusion of a male gamete with two polar nuclei. Both serve as nutritive tissues, but they differ in their origin and ploidy.

80. (1) endosperm
Albuminous or endospermic seeds are characterized by the presence of a significant amount of endosperm at maturity. This triploid tissue serves as the primary reservoir for reserve food materials, which are utilized by the embryo during the early stages of germination. Common examples include monocots like wheat, maize, and coconut, as well as some dicots like the castor bean plant.

81. (2) 2, 3, 5 triphenyl tetrazolium chloride
The viability of seeds is a measure of their ability to germinate under favorable conditions. This can be accurately tested using 2, 3, 5 triphenyl tetrazolium chloride, a chemical that indicates the presence of respiratory activity in living tissues. Living embryos reduce this colorless salt into a red-colored compound called formazan, thereby identifying viable seeds within a sample.

82. (1) papaya
Papaya is a dioecious plant, meaning that individual plants are either male or female. Since a single plant only produces one type of reproductive organ, pollination must occur between flowers on two different individuals. This requirement for cross-pollination effectively prevents both autogamy, which occurs in a single flower, and geitonogamy, which occurs between different flowers on the same individual plant.

83. (2) sporopollenin
Sporopollenin is an exceptionally resistant organic material that forms the outer layer of the pollen grain, known as the exine. It is highly durable and can withstand environmental extremes, including high temperatures and chemical exposure to strong acids or alkalis. Additionally, there are no known biological enzymes capable of degrading it. This resilience ensures that pollen grains are exceptionally well-preserved as fossils.

84. (1) Commelina
Commelina is known for producing both chasmogamous flowers, which open normally, and cleistogamous flowers, which remain closed. In cleistogamous flowers, the anthers and stigma are in close proximity within the bud, ensuring that self-pollination occurs internally. This mechanism guarantees successful seed-setting even in the complete absence of external pollinating agents like insects or wind, providing a reliable reproductive strategy for the plant.

85. (3) Initiation of pollen tube
The germ pore is a specific region on the exine of a pollen grain where the protective layer of sporopollenin is either very thin or entirely absent. This specialized opening serves as the site for the initiation and emergence of the pollen tube during germination. Once a compatible pollen grain lands on a stigma, the tube grows out through the germ pore toward the ovary.

86. (4) wind.
Wind-pollinated plants, or anemophilous species, typically exhibit specific floral adaptations for abiotic pollen transfer. Their ovaries often contain only a single ovule, and many small flowers are frequently grouped into compact inflorescences to maximize the probability of capturing airborne pollen. Unlike animal-pollinated flowers, these are usually inconspicuous and lack features like bright colors, fragrance, or nectar since they do not attract biotic vectors.

87. (1) When pollen is shed at two-celled stage, double fertilisation does not take place.
Even when pollen is shed at the two-celled stage, double fertilisation still takes place. In most angiosperms, pollen is shed at the two-celled stage, consisting of a large vegetative cell and a smaller generative cell. Double fertilization still occurs because the generative cell divides into two male gametes while the pollen tube grows through the style. Other statements regarding the relative cell sizes, intine composition of cellulose and pectin, and long-term pollen viability are biologically correct.

88. (3) synergid
The filiform apparatus is a specialized cellular structure characterized by finger-like wall thickenings located at the micropylar end of the synergids. These synergids are part of the egg apparatus within the mature embryo sac. The

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147. (4) apomictic diploid.
A nucellar embryo is formed through a process of asexual reproduction known as apomixis. It develops directly from the diploid sporophytic cells of the nucellus without the occurrence of meiosis or fertilization. Because it originates from the mother plant's tissues, the resulting embryo is diploid and genetically identical to the parent, ensuring the consistent propagation of the maternal genetic traits in the offspring.

148. (4) parthenogenesis.
Parthenogenesis is a form of reproduction where an embryo develops from an unfertilized egg cell or female gamete. This process occurs naturally in various plants and animals, bypassing the need for male gametes and fertilization. It is distinct from parthenocarpy, which refers specifically to the development of fruit without seeds, and from other forms of apomixis like adventitive embryony that involve sporophytic tissues.

149. (3) 125
To produce one hundred wheat grains, both male and female gametes are required. For the male side, twenty-five meiotic divisions in microspore mother cells produce one hundred pollen grains. For the female side, one hundred meiotic divisions in megaspore mother cells produce one hundred functional megaspores. Combining these requirements results in a total of one hundred twenty-five meiotic divisions for the process.

150. (2) three celled pollen grain
The male gametophyte of angiosperms, or the pollen grain, can be shed from the anther at either the two-celled or three-celled stage. In many species, including many monocots and some dicots, the generative cell divides before dispersal, resulting in a pollen grain that contains one vegetative cell and two male gametes. This three-celled stage represents a more advanced state of male gametophyte development.

151. (2) Nawaschin and Guignard
The significant discovery of double fertilization and triple fusion in angiosperms was made by Sergei Nawaschin and Leon Guignard in the late nineteenth century. Their research revealed that two separate fusion events occur simultaneously within the embryo sac, leading to the formation of both the zygote and the endosperm. This finding was a major milestone in understanding the unique reproductive biology of flowering plants.

152. (1) apospory
Apospory involves the development of a gametophyte directly from the sporophytic tissues, such as the nucellus or integument, without the occurrence of meiosis or spore formation. This results in a diploid gametophyte. This phenomenon is a form of apomixis that bypasses the normal reductional division, allowing the plant to propagate while maintaining the genetic composition of the parent sporophyte generation.

153. (2) apogamy
Apogamy is a type of asexual reproduction where a sporophyte develops directly from the cells of the gametophyte or prothallus without the occurrence of gametic fusion or fertilization. This process results in the formation of a sporophytic plant that typically has the same ploidy level as the gametophyte, bypassing the sexual phase of the life cycle in certain ferns and other plants.

NODIA
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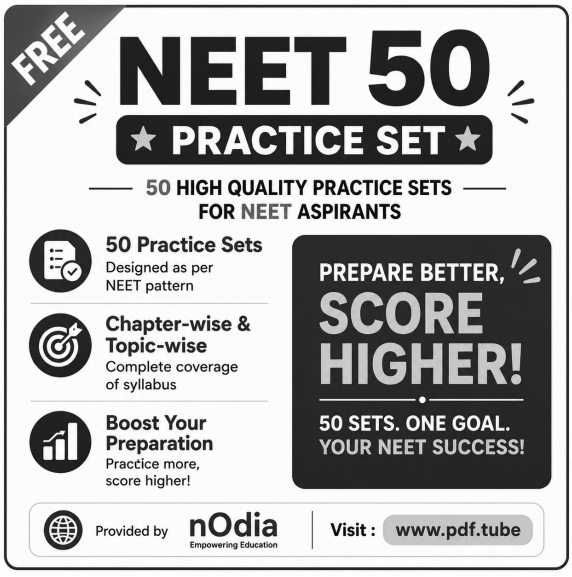

cell known as a zygote. This process restores the diploid chromosome number and combines genetic material from two different parents, leading to genetic variation in the resulting offspring of the species.

138. (2) Antipodal cells and egg cell
In the angiosperm embryo sac, the cells are derived from a haploid megaspore through mitotic divisions. Consequently, the antipodal cells and the egg cell are both haploid structures, containing a single set of chromosomes. Other structures like the nucellus and megaspore mother cell are part of the diploid sporophytic generation, while the primary endosperm nucleus is typically a triploid tissue.

139. (3) ovule
The embryo sac is the mature female gametophyte of angiosperms, and it is located deep within the tissues of the ovule. It is enclosed by the nucellus and one or two protective layers called integuments. The embryo sac contains the essential reproductive cells, including the egg apparatus and polar nuclei, and serves as the specific site where double fertilization takes place.

140. (3) porogamy
Porogamy is the most common pathway for the entry of the pollen tube into the ovule in angiosperms. In this process, the pollen tube grows toward the micropyle and enters the ovule through this specific opening. This contrasts with other methods such as chalazogamy, where the tube enters through the chalazal end, or mesogamy, where it penetrates through the integuments or the funicle.

141. (3) embryo sac
In the reproductive cycle of angiosperms, the female gametophyte generation is highly reduced and is represented by the embryo sac. This structure develops from a haploid megaspore and typically contains seven cells and eight nuclei at maturity. It is entirely dependent on the surrounding sporophytic tissues of the ovule for nutrition and protection while housing the egg cell necessary for sexual reproduction.

142. (3) microspore
The microspore represents the first cell of the male gametophyte generation in angiosperms. Upon maturation, it develops into a pollen grain, which is the functional male gametophyte. The pollen grain contains the vegetative and generative cells required for gamete production and delivery to the female gametophyte. Other structures like the microsporangium, nucellus, and stamen are part of the diploid sporophytic generation.

143. (3) inner integument
Following fertilization, the ovule undergoes various changes to transform into a seed. The protective layers, or integuments, of the ovule mature into the seed coats. Specifically, the outer integument develops into the hard outer seed coat called the testa, while the inner integument develops into the thin, membranous inner seed coat known as the tegmen, providing essential protection for the embryo.

144. (1) Gametes are invariably haploid.
In sexual reproduction, gametes are the specialized reproductive cells that must have a haploid set of chromosomes. This is necessary so that when two gametes fuse during fertilization, the resulting zygote restores the original diploid chromosome number of the species. Unlike spores, which can sometimes be diploid in certain life cycles, gametes are universally and invariably haploid across all sexually reproducing organisms.

145. (1) vegetative cell is not damaged
The pollen grain consists of a vegetative cell and a generative cell. The vegetative cell is responsible for the metabolic activity and the actual growth of the pollen tube. Even if the generative cell is destroyed by a laser, the vegetative cell can still function and drive the elongation of the pollen tube toward the ovary, although fertilization cannot occur because no male gametes are produced.

146. (2) persistent nucellus
Perisperm is a nutritive tissue found in some seeds that originates from the nucellus. In most plants, the nucellus is completely consumed during development, but in species like black pepper and beet, it remains as a persistent diploid tissue. This perisperm provides additional food reserves for the developing embryo, functioning similarly to but originating differently from the triploid endosperm tissue found in many seeds.

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2026 (CANCELLED)

8. Arrange the following cell layers/structures around the female gamete, from outer to inner side:

A. Zona pellucida
B. Perivitelline space
C. Corona radiata
D. Plasma membrane of ovum

(1) D, B, A, C
(2) C, A, D, B
(3) C, A, B, D
(4) A, C, B, D

2025

9. Match List-I with List-II.

	List-I		List-II
A.	Head	I.	Enzymes
B.	Acrosome	II.	Sperm motility
C.	Middle piece	III.	Energy
D.	Tail	IV.	Genetic material

Choose the correct answer from the options given below:

(1) A-III, B-IV, C-II, D-I
(2) A-III, B-II, C-I, D-IV
(3) A-IV, B-III, C-I, D-II
(4) A-IV, B-III, C-II, D-I

2025

10. The first menstruation is called

(1) diapause (2) ovulation
(3) menopause (4) menarche.

2025

11. Consider the following:

A. The reductive division for the human female gametogenesis starts earlier than that of the male gametogenesis.
B. The gap between the first meiotic division and the second meiotic division is much shorter for males compared to females.
C. The first polar body is associated with the formation of the primary oocyte.
D. Luteinizing Hormone (LH) surge leads to disintegration of the endometrium and onset of menstrual bleeding.

Choose the correct answer from the options given below.

(1) B and D are true.
(2) B and C are true.
(3) A and B are true.
(4) A and C are true.

NODIA

2025

12. Find the correct statements :

A. In human pregnancy, the major organ systems are formed at the end of 12 weeks.
B. In human pregnancy the major organ systems are formed at the end of 8 weeks.
C. In human pregnancy heart is formed after one month of gestation.
D. In human pregnancy, limbs and digits develop by the end of second month.
E. In human pregnancy the appearance of hair is usually observed in the fifth month.

Choose the correct answer from the options given below.

(1) B, C, D and E Only
(2) A, C, D and E Only
(3) A and E Only
(4) B and C Only

RE-EXAM 2024

13. Arrange the following parts in human mammary gland, traversing the route of milk ejection.

A. Mammary duct
B. Lactiferous duct
C. Mammary alveolus
D. Ampulla
E. Mammary tubule

Choose the correct answer from the options given below.

(1) D → C → E → A → B
(2) C → E → B → A → D
(3) C → E → A → D → B
(4) A → C → E → D → B

2024

14. Match List-I with List-II.

	List-I (Structures)		List-II (Features)
A.	Mons pubis	I.	A fleshy fold of tissue surrounding the vaginal opening
B.	Clitoris	II.	Fatty cushion of cells covered by skin and hair
C.	Hymen	III.	Tiny finger-like structure above labia minora
D.	Labia majora	IV.	A thin membrane-like structure covering vaginal opening

2012

68. The Leydig's cells as found in the human body are the secretory source of
(1) progesterone
(2) intestinal mucus
(3) glucagon
(4) androgens.

2012

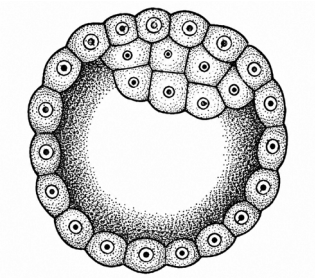
69. Which one of the following statements is false in respect of viability of mammalian sperm?
(1) Sperm is viable for only up to 24 hours.
(2) Survival of sperm depends on the pH of the medium and is more active in alkaline medium.
(3) Viability of sperm is determined by its motility.
(4) Sperms must be concentrated in a thick suspension.

Mains 2012

70. The secretory phase in the human menstrual cycle is also called
(1) luteal phase and lasts for about 6 days
(2) follicular phase and lasts for about 6 days
(3) luteal phase and lasts for about 13 days
(4) follicular phase and lasts for about 13 days.

Mains 2012

71. Identify the human developmental stage shown as well as the related right place of its occurrence in a normal pregnant woman and select the right option for the two, together.



	Developmental stage		**Site of Occurrence**
(1)	Late morula	-	Middle part of fallopian tube
(2)	Blastula	-	End part of fallopian tube
(3)	Blastocyst	-	Uterine wall
(4)	8-celled morula	-	Starting point of fallopian tube

2012

72. Signals for parturition originate from
(1) both placenta as well as fully developed fetus
(2) oxytocin released from maternal pituitary
(3) placenta only
(4) fully developed fetus only.

2011

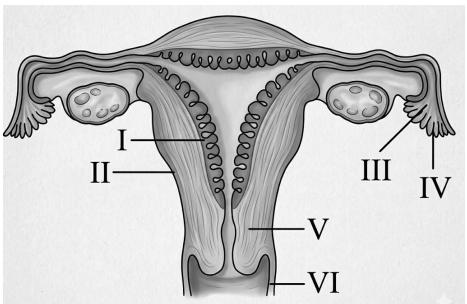
73. If for some reason, the vasa efferentia in the human reproductive system get blocked, the gametes will not be transported from
(1) testes to epididymis
(2) epididymis to vas deferens
(3) ovary to uterus
(4) vagina to uterus.

2011

74. The testes in humans are situated outside the abdominal cavity inside a pouch called scrotum. The purpose served is for
(1) maintaining the scrotal temperature lower than the internal body temperature
(2) escaping any possible compression by the visceral organs
(3) providing more space for the growth of epididymis
(4) providing a secondary sexual feature for exhibiting the male sex.

2011

75. The figure given below depicts a diagrammatic sectional view of the human female reproductive system. Which set of three parts out of I-VI have been correctly identified?



(1) (II) Endometrium, (III) Infundibulum, (IV) Fimbriae
(2) (III) Infundibulum, (IV) Fimbriae, (V) Cervix
(3) (IV) Oviducal funnel, (V) Uterus, (VI) Cervix
(4) (I) Perimetrium, (II) Myometrium, (III) Fallopian tube

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2024

21. Given below are two statements : One is labelled as Assertion A and the other is labelled as reason R.
Assertion A : Breast-feeding during initial period of infant growth is recommended by doctors for bringing a healthy baby.
Reason R : Colostrum contains several antibodies absolutely essential to develop resistance for the new born baby.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Both A and R are correct and R is the correct explanation of A.
(2) Both A and R are correct but R is NOT the correct explanation of A.
(3) A is correct but R is not correct.
(4) A is not correct but R is correct.

2023

22. Given below are two statements:
Statement I: Vas deferens receives a duct from seminal vesicle and opens into urethra as the ejaculatory duct.
Statement II: The cavity of the cervix is called cervical canal which along with vagina forms birth canal.
In the light of the above statements, choose the correct answer from the options given below:
(1) Statement I is correct but Statement II is false.
(2) Statement I incorrect but Statement II is true.
(3) Both Statement I and Statement II are true.
(4) Both Statement I and Statement II are false.

Manipur NEET 2023

23. Given below are two statements regarding oogenesis.
Statement I : The primary follicles get surrounded by more layers of granulosa cells, a theca and shows fluid filled cavity antrum. Now it is called secondary follicle.
Statement II : Graafian follicle ruptures to release the secondary oocyte from the ovary by the process called ovulation.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is correct but statement II is false.
(2) Statement I is incorrect but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

Manipur NEET 2023

24. Arrange the sequence of different hormones for their role during gametogenesis.
(A) Gonadotropin LH stimulates synthesis and secretion of androgen.
(B) Gonadotropin releasing hormone from hypothalamus.
(C) Androgen stimulates spermatogenesis.
(D) Gonadotropin FSH helps in the process of spermiogenesis.
(E) Gonadotropins from anterior pituitary gland.
Choose the correct answer form the options given below :
(1) (E), (A), (D), (B), (C)
(2) (C), (A), (D), (E), (B)
(3) (B), (E), (A), (C), (D)
(4) (D), (B), (A), (C), (E)

2023

25. Which of the following statements are correct regarding female reproductive cycle?
A. In non-primate mammals cyclical changes during reproduction are called oestrus cycle.
B. First menstrual cycle begins at puberty and is called menopause.
C. Lack of menstruation may be indicative of pregnancy.
D. Cyclic menstruation extends between menarche and menopause.
Choose the most appropriate answer from the options given below:
(1) A, B and C only
(2) A, C and D only
(3) A and D only
(4) A and B only

NODIA

2023

26. Given below are two statements.
One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Endometrium is necessary for implantation of blastocyst.
Reason (R) : In the absence of fertilization, the corpus luteum degenerates that causes disintegration of endometrium.
In the light of the above statements, choose the correct answer from the options given below:
(1) (A) is true but (R) is false.
(2) A is false but (R) is true.
(3) Both (A) and (R) are true and (R) is the correct explanation of (A).
(4) Both (A) and (R) are true but (R) is not the correct explanation of (A).

Choose the correct answer from the options given below.
(1) A-II, B-III, C-IV, D-I
(2) A-IV, B-III, C-II, D-I
(3) A-I, B-IV, C-III, D-II
(4) A-II, B-III, C-I, D-IV

2024

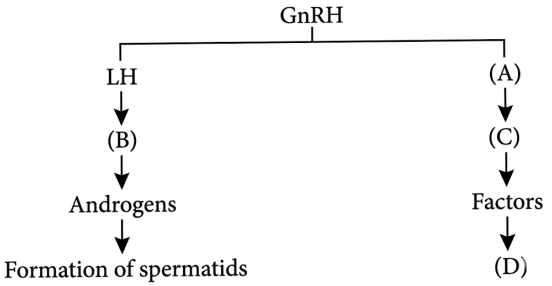
15. Given below are two statements.
Statement I : The presence or absence of hymen is not a reliable indicator of virginity.
Statement II : The hymen is torn during the first coitus only.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are true.
(2) Both Statement I and Statement II are false.
(3) Statement I is true but Statement II is false.
(4) Statement I is false but Statement II is true.

2024

16. Which of the following is not a component of fallopian tube?
(1) Uterine fundus
(2) Isthmus
(3) Infundibulum
(4) Ampulla

2024

17. Identify the correct option (A), (B), (C), (D) with respect to spermatogenesis.



(1) FSH, Leydig's cells, Sertoli cells, Spermiogenesis
(2) ICSH, Interstitial cells, Leydig's cells, Spermiogenesis
(3) FSH, Sertoli cells, Leydig's cells, spermatogenesis
(4) ICSH, Leydig's cells, Sertoli cells, Spermatogenesis.

RE-EXAM 2024

18. Given below are two statements: One is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : During menstrual cycle, the ovulation takes place approximately on 14th day.
Reason (R) : Rapid secretion of LH in the middle of menstrual cycle induces rupture of Graafian follicle and thereby the release of ovum.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) A is correct but R is not correct.
(2) A is not correct but R is correct.
(3) Both A and R are correct and R is the correct explanation of A.
(4) Both A and R are correct but R is not the correct explanation of A.

2024

19. Given below are two statements : One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : FSH acts upon ovarian follicles in female and Leydig's cells in male.
Reason R : Growing ovarian follicles secrete estrogen in female while interstitial cells secrete androgen in male human being.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both A and R are true and R is the correct explanation of A.
(2) Both A and R are true but R is NOT the correct explanation of A.
(3) A is true but R is false.
(4) A is false but R is true.

RE-EXAM 2024

20. Match List-I with List-II.

	List-I		List-II
A.	Parturition	I.	Several antibodies for new-born babies
B.	Placenta	II.	Collection of ovum after ovulation
C.	Colostrum	III.	Foetal ejection reflex
D.	Fimbriae	IV.	Secretion of the hormone hCG

Choose the correct answer from the options given below.
(1) A-III, B-IV, C-I, D-II
(2) A-I, B-IV, C-II, D-III
(3) A-II, B-III, C-IV, D-I
(4) A-III, B-IV, C-II, D-I

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2019

36. Select the correct sequence for transport of sperm cells in male reproductive system.
(1) Testis → Epididymis → Vasa efferentia → Vas deferens → Ejaculatory duct → Inguinal canal → Urethra → Urethral meatus
(2) Testis → Epididymis → Vasa efferentia → Rete testis → Inguinal canal → Urethra
(3) Seminiferous tubules → Rete testis → Vasa efferentia → Epididymis → Vas deferens → Ejaculatory duct → Urethra → Urethral meatus
(4) Seminiferous tubules → Vasa efferentia → Epididymis → Inguinal canal → Urethra

Odisha NEET 2019

37. No new follicles develop in the luteal phase of the menstrual cycle because
(1) follicles do not remain in the ovary after ovulation
(2) FSH levels are high in the luteal phase
(3) LH levels are high in the luteal phase
(4) both FSH and LH levels are low in the luteal phase.

2019, 1993

38. Extrusion of second polar body from egg occurs
(1) simultaneously with first cleavage
(2) after entry of sperm but before fertilisation
(3) after fertilisation
(4) before entry of sperm into ovum.

2018

39. The difference between spermiogenesis and spermiation is
(1) in spermiogenesis spermatids are formed, while in spermiation spermatozoa are formed
(2) in spermiogenesis spermatozoa are formed, while in spermiation spermatids are formed
(3) in spermiogenesis spermatozoa from Sertoli cells are released into the cavity of seminiferous tubules, while in spermiation spermatozoa are formed
(4) in spermiogenesis spermatozoa are formed, while in spermiation spermatozoa are released from Sertoli cells into the cavity of seminiferous tubules.

2018

40. Match the items given in column I with those in column II and select the correct option given below.

	Column I		Column II
A.	Proliferative phase	(i)	Breakdown of endometrial lining
B.	Secretory phase	(ii)	Follicular phase
C.	Menstruation	(iii)	Luteal phase

(1) A-(iii), B-(ii), C-(i)
(2) A-(i), B-(iii), C-(ii)
(3) A-(ii), B-(iii), C-(i)
(4) A-(iii), B-(i), C-(ii)

2018

41. Hormones secreted by the placenta to maintain pregnancy are
(1) hCG, hPL, progestogens, prolactin
(2) hCG, hPL, estrogens, relaxin, oxytocin
(3) hCG, hPL, progestogens, estrogens
(4) hCG, progestogens, estrogens, glucocorticoids.

2018

42. The amnion of mammalian embryo is derived from
(1) ectoderm and mesoderm
(2) endoderm and mesoderm
(3) mesoderm and trophoblast
(4) ectoderm and endoderm.

2017

43. Capacitation occurs in
(1) epididymis
(2) vas deferens
(3) female reproductive tract
(4) rete testis.

NEET-II 2016

44. Which of the following depicts the correct pathway of transport of sperms?
(1) Rete testis → Efferent ductules → Epididymis → Vas deferens
(2) Rete testis → Epididymis → Efferent ductules → Vas deferens
(3) Rete testis → Vas deferens → Efferent ductules → Epididymis
(4) Efferent ductules → Rete testis → Vas deferens → Epididymis

NEET-I 2016

45. Changes in GnRH pulse frequency in females is controlled by circulating levels of
(1) progesterone only
(2) progesterone and inhibin
(3) estrogen and progesterone
(4) estrogen and inhibin.

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2022

27. Given below are two statements:
Statement I : The release of sperms into the seminiferous tubules is called spermiation.
Statement II : Spermiogenesis is the process of formation of sperms from spermatogonia.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Both Statement I and Statement II are correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is correct but Statement II is incorrect
(4) Statement I is incorrect but Statement II is correct

2022

28. Which of the following statements are true for spermatogenesis but do not hold true for oogenesis?
(A) It results in the formation of haploid gametes.
(B) Differentiation of gamete occurs after the completion of meiosis.
(C) Meiosis occurs continuously in a mitotically dividing stem cell population.
(D) It is controlled by the Luteinising Hormone (LH) and Follicle Stimulating Hormone (FSH) secreted by the anterior pituitary.
(E) It is initiated at puberty.
Choose the most appropriate answer from the options given below:
(1) (A) and (E) only
(2) (B) and (C) only
(3) (B), (D) and (E) only
(4) (B), (C) and (E) only

2022

29. At which stage of life the oogenesis process is initiated?
(1) Puberty
(2) Embryonic development stage
(3) Birth
(4) Adult

2021

30. Receptors for sperm binding in mammals are present on
(1) zona pellucida
(2) corona radiata
(3) vitelline membrane
(4) perivitelline space

2021

31. Which of the following secretes the hormone, relaxin, during the later phase of pregnancy?
(1) Uterus
(2) Graafian follicle
(3) Corpus luteum
(4) Fetus

2021

32. Which of these is not an important component of initiation of parturition in humans?
(1) Release of prolactin
(2) Increase in estrogen and progesterone ratio
(3) Synthesis of prostaglandins
(4) Release of oxytocin

2020

33. Meiotic division of the secondary oocyte is completed
(1) prior to ovulation
(2) at the time of copulation
(3) after zygote formation
(4) at the time of fusion of a sperm with an ovum.

2020

34. Which of the following hormone levels will cause release of ovum (ovulation) from the Graafian follicle?
(1) High concentration of Estrogen
(2) High concentration of Progesterone
(3) Low concentration of LH
(4) Low concentration of FSH

2020

35. Match the following columns and select the correct option.

	Column I		Column II
A.	Placenta	(i)	Androgens
B.	Zona pellucida	(ii)	Human Chorionic Gonadotropin (HCG)
C.	Bulbourethral glands	(iii)	Layer of the ovum
D.	Leydig cells	(iv)	Lubrication of the penis

(1) (A)-(iv), (B)-(iii), (C)-(i), (D)-(ii)
(2) (A)-(i), (B)-(iv), (C)-(ii), (D)-(iii)
(3) (A)-(iii), (B)-(ii), (C)-(iv), (D)-(i)
(4) (A)-(ii), (B)-(iii), (C)-(iv), (D)-(i)

NODIA

(3) pregnancies with genetic abnormality
(4) implantation of embryo at site other than uterus.

2015 Cancelled

58. Which of these is not an important component of initiation of parturition in humans?
(1) Release of oxytocin
(2) Release of prolactin
(3) Increase in estrogen and progesterone ratio
(4) Synthesis of prostaglandins

2014

59. The shared terminal duct of the reproductive and urinary system in the human male is
(1) urethra
(2) ureter
(3) vas deferens
(4) vasa efferentia.

2014

60. The main function of mammalian corpus luteum is to produce
(1) estrogen only
(2) progesterone
(3) human chorionic gonadotropin
(4) relaxin only.

2014, 2012

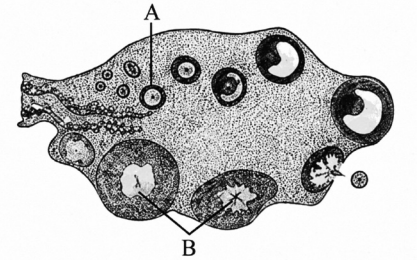
61. Select the correct option describing gonadotropin activity in a normal pregnant female.
(1) High level of FSH and LH stimulates the thickening of endometrium.
(2) High level of FSH and LH facilitates implantation of the embryo.
(3) High level of hCG stimulates the synthesis of estrogen and progesterone.
(4) High level of hCG stimulates the thickening of endometrium.

2013

62. What is the correct sequence of sperm formation?
(1) Spermatogonia, spermatozoa, spermatocytes, spermatids
(2) Spermatogonia, spermatocytes, spermatids, spermatozoa
(3) Spermatids, spermatocytes, spermatogonia, spermatozoa
(4) Spermatogonia, spermatocytes, spermatozoa, spermatids

Karnataka NEET 2013

63. The figure shows a section of human ovary. Select the option which gives the correct identification of either A or B with function/characteristic.



(1) B - Corpus luteum - Secretes progesterone
(2) A - Tertiary follicle- Forms Graafian follicle
(3) B - Corpus luteum - Secretes estrogen
(4) A - Primary oocyte - It is in the prophase I of the meiotic division

2013

64. Menstrual flow occurs due to lack of
(1) oxytocin
(2) vasopressin
(3) progesterone
(4) FSH.

Karnataka NEET 2013

65. In our society women are blamed for producing female children. Choose the correct answer for the sex-determination in humans.
(1) Due to some defect like aspermia in man.
(2) Due to the genetic make up of the particular sperm which fertilises the egg.
(3) Due to the genetic make up of the egg.
(4) Due to some defect in the women.

2013

66. Which one of the following is not the function of placenta?
(1) Facilitates removal of carbon dioxide and waste material from embryo
(2) Secretes oxytocin during parturition
(3) Facilitates supply of oxygen and nutrients to embryo
(4) Secretes estrogen

Karnataka NEET 2013

67. The fetal ejection reflex in humans triggers the release of
(1) oxytocin from fetal pituitary
(2) human chorionic gonadotropin (hCG) from placenta
(3) human placental lactogen (hPL) from placenta
(4) oxytocin from maternal pituitary.

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NEET-I 2016

46. Select the incorrect statement.
(1) LH and FSH decrease gradually during the follicular phase.
(2) LH triggers secretion of androgens from the Leydig cells.
(3) FSH stimulates the Sertoli cells which help in spermiogenesis.
(4) LH triggers ovulation in ovary.

NEET-I 2016

47. Identify the correct statement on 'inhibin'.
(1) Is produced by granulosa cells in ovary and inhibits the secretion of LH
(2) Is produced by nurse cells in testes and inhibits the secretion of LH
(3) Inhibits the secretion of LH, FSH and prolactin
(4) Is produced by granulosa cells in ovary and inhibits the secretion of FSH

NEET-I 2016

48. Fertilisation in humans is practically feasible only if
(1) the ovum and sperms are transported simultaneously to ampullary-isthmic junction of the cervix
(2) the sperms are transported into cervix within 48 hrs of release of ovum in uterus
(3) the sperms are transported into vagina just after the release of ovum in fallopian tube
(4) the ovum and sperms are transported simultaneously to ampullary-isthmic junction of the fallopian tube.

NEET-II 2016

49. Match column I with column II and select the correct option using the given codes.

	Column I		Column II
A.	Mons pubis	(i)	Embryo formation
B.	Antrum	(ii)	Sperm
C.	Trophectoderm	(iii)	Female external genitalia
D.	Nebenkern	(iv)	Graafian follicle

(1) A-(iii), B-(iv), C-(ii), D-(i)
(2) A-(iii), B-(iv), C-(i), D-(ii)
(3) A-(iii), B-(i), C-(iv), D-(ii)
(4) A-(i), B-(iv), C-(iii), D-(ii)

NEET-II 2016

50. Several hormones like hCG, hPL, estrogen, progesterone are produced by
(1) ovary
(2) placenta
(3) fallopian tube
(4) pituitary.

2015 Cancelled

51. Hysterectomy is surgical removal of
(1) vas deferens
(2) mammary glands
(3) uterus
(4) prostate gland.

2015

52. Which of the following layers in an antral follicle is acellular?
(1) Stroma (2) Zona pellucida
(3) Granulosa (4) Theca interna

2015 Cancelled

53. Which of the following cells during gametogenesis is normally diploid?
(1) Spermatogonia
(2) Secondary polar body
(3) Primary polar body
(4) Spermatid

2015

54. Which of the following events is not associated with ovulation in human female?
(1) Release of secondary oocyte
(2) LH surge
(3) Decrease in estradiol
(4) Full development of Graafian follicle

2015

55. In human females, meiosis-II is not completed until
(1) uterine implantation
(2) birth
(3) puberty
(4) fertilisation.

NODIA

2015 Cancelled

56. Capacitation refers to changes in the
(1) ovum after fertilisation
(2) sperm after fertilisation
(3) sperm before fertilisation
(4) ovum before fertilisation.

2015

57. Ectopic pregnancies are referred to as
(1) implantation of defective embryo in the uterus
(2) pregnancies terminated due to hormonal imbalance

Mains 2011

76. About which day in a normal human menstrual cycle does rapid secretion of LH (popularly called LH surge) normally occurs?
(1) 14th day
(2) 20th day
(3) 5th day
(4) 11th day

Mains 2011

77. What happens during fertilisation in humans after many sperms reach close to the ovum?
(1) Secretions of acrosome helps one sperm enter cytoplasm of ovum through zona pellucida.
(2) All sperms except the one nearest to the ovum lose their tails.
(3) Cells of corona radiata trap all the sperms except one.
(4) Only two sperms nearest the ovum penetrate zona pellucida.

2010

78. Sertoli cells are found in
(1) ovaries and secrete progesterone
(2) adrenal cortex and secrete adrenaline
(3) seminiferous tubules and provide nutrition to germ cells
(4) pancreas and secrete cholecystokinin.

2010

79. Vasa efferentia are the ductules leading from
(1) testicular lobules to rete testis
(2) rete testis to vas deferens
(3) vas deferens to epididymis
(4) epididymis to urethra.

2010

80. Seminal plasma in human males is rich in
(1) fructose and calcium
(2) glucose and calcium
(3) DNA and testosterone
(4) ribose and potassium.

Mains 2010

81. Secretions from which one of the following are rich in fructose, calcium and some enzymes?
(1) Male accessory glands
(2) Liver
(3) Pancreas
(4) Salivary glands

2010

82. The part of fallopian tube closest to the ovary is
(1) isthmus (2) infundibulum
(3) cervix (4) ampulla.

2010

83. Which one of the following statements about human sperm is correct?
(1) Acrosome has a conical pointed structure used for piercing and penetrating the egg, resulting in fertilisation.
(2) The sperm lysins in the acrosome dissolve the egg envelope facilitating fertilisation.
(3) Acrosome serves as a sensory structure leading the sperm towards the ovum.
(4) Acrosome serves no particular function.

2010

84. The second maturation division of the mammalian ovum occurs
(1) shortly after ovulation before the ovum makes entry into the fallopian tube
(2) until after the ovum has been penetrated by a sperm
(3) until the nucleus of the sperm has fused with that of the ovum
(4) in the Graafian follicle following the first maturation division.

2010

85. Which one of the following statements about morula in humans is correct?
(1) It has almost equal quantity of cytoplasm as an uncleaved zygote but much more DNA.
(2) It has far less cytoplasm as well as less DNA than in an uncleaved zygote.
(3) It has more or less equal quantity of cytoplasm and DNA as in uncleaved zygote.
(4) It has more cytoplasm and more DNA than an uncleaved zygote.

Mains 2010

86. In human female, the blastocyst
(1) forms placenta even before implantation
(2) gets implanted into uterus 3 days after ovulation
(3) gets nutrition from uterine endometrial secretion only after implantation
(4) gets implanted in endometrium by the trophoblast cells.

2010

87. The first movements of the fetus and appearance of hair on its head are usually observed during which month of pregnancy?
(1) Fourth month
(2) Fifth month
(3) Sixth month
(4) Third month

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Mains 2010

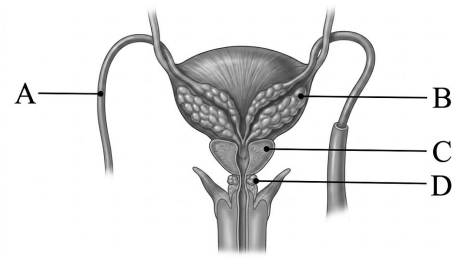
88. Signals from fully developed fetus and placenta ultimately lead to parturition which requires the release of
(1) estrogen from placenta
(2) oxytocin from maternal pituitary
(3) oxytocin from fetal pituitary
(4) relaxin from placenta.

2009

89. Seminal plasma in humans is rich in
(1) fructose and calcium but has no enzymes
(2) glucose and certain enzymes but has no calcium
(3) fructose and certain enzymes but poor in calcium
(4) fructose, calcium and certain enzymes.

2009

90. Given below is a diagrammatic sketch of a portion of human male reproductive system. Select the correct set of the names of the parts labelled A, B, C, D.



(1) A-Vas deferens, B-Seminal vesicle, C-Prostate, D-Bulbourethral gland
(2) A-Vas deferens, B-Seminal vesicle, C-Bulbourethral gland, D-Prostate
(3) A-Ureter, B-Seminal vesicle, C-Prostate, D-Bulbourethral gland
(4) A-Ureter, B-Prostate, C-Seminal vesicle, D-Bulbourethral gland

2009

91. The correct sequence of spermatogenetic stages leading to the formation of sperms in a mature human testis is
(1) spermatogonia - spermatocyte - spermatid - sperms
(2) spermatid - spermatocyte - spermatogonia - sperms
(3) spermatogonia - spermatid - spermatocyte - sperms
(4) spermatocyte - spermatogonia - spermatid - sperms.

2009

92. Which one of the following is the correct matching of the events occurring during menstrual cycle?
(1) Proliferative phase: Rapid regeneration of myometrium and maturation of Graafian follicle
(2) Secretory phase : Development of corpus luteum and increased secretion of progesterone
(3) Menstruation : Breakdown of myometrium and ovum not fertilised
(4) Ovulation : LH and FSH attain peak level and sharp fall in the secretion of progesterone

2009

93. Which one of the following is the most likely root cause why menstruation is not taking place in regularly cycling human female?
(1) Maintenance of the hypertrophical endometrial lining
(2) Maintenance of high concentration of sex-hormones in the bloodstream
(3) Retention of well-developed corpus luteum
(4) Fertilisation of the ovum

NODIA

2009

94. A change in the amount of yolk and its distribution in the egg will affect
(1) pattern of cleavage
(2) number of blastomeres produced
(3) fertilisation
(4) formation of zygote.

2009

95. Fetal ejection reflex in human female is induced by
(1) release of oxytocin from pituitary
(2) fully developed fetus and placenta
(3) differentiation of mammary glands
(4) pressure exerted by amniotic fluid.

2008

96. In humans, at the end of the first meiotic division, the male germ cells differentiate into the
(1) spermatids
(2) spermatogonia
(3) primary spermatocytes
(4) secondary spermatocytes.

2008

97. Which one of the following statements is incorrect about menstruation?
(1) At menopause in the female, there is especially abrupt increase in gonadotropic hormones.

(2) The beginning of the cycle of menstruation is called menarche.
(3) During normal menstruation about 40 mL blood is lost.
(4) The menstrual fluid can easily clot.

2008

98. Which extra embryonic membrane in humans prevents desiccation of the embryo inside the uterus?
(1) Yolk sac
(2) Amnion
(3) Chorion
(4) Allantosis

2008

99. In human adult females oxytocin
(1) stimulates pituitary to secrete vasopressin
(2) causes strong uterine contractions during parturition
(3) is secreted by anterior pituitary
(4) stimulates growth of mammary glands.

2007

100. Which part of ovary in mammals acts as an endocrine gland after ovulation?
(1) Stroma
(2) Germinal epithelium
(3) Vitelline membrane
(4) Graafian follicle

2007

101. In the human female, menstruation can be deferred by the administration of
(1) combination of FSH and LH
(2) combination of estrogen and progesterone
(3) FSH only
(4) LH only.

2006

102. Sertoli cells are regulated by the pituitary hormone known as
(1) LH
(2) FSH
(3) GH
(4) prolactin.

2006

103. Withdrawal of which of the following hormones is the immediate cause of menstruation?
(1) Progesterone
(2) Estrogen
(3) FSH
(4) FSH-RH

2005

104. If mammalian ovum fails to get fertilised, which one of the following is unlikely?
(1) Corpus luteum will disintegrate.
(2) Progesterone secretion rapidly declines.
(3) Estrogen secretion further increases.
(4) Primary follicle starts developing.

2005

105. Grey crescent is the area
(1) at the point of entry of sperm into ovum
(2) just opposite to the site of entry of sperm into ovum
(3) at the animal pole
(4) at the vegetal pole.

2004

106. Ovulation in the human female normally takes place during the menstrual cycle
(1) at the mid secretory phase
(2) just before the end of the secretory phase
(3) at the beginning of the proliferative phase
(4) at the end of the proliferative phase.

2004

107. Which of the following hormones is not a secretion product of human placenta?
(1) Human chorionic gonadotropin
(2) Prolactin
(3) Estrogen
(4) Progesterone

2003

108. Bartholin's glands are situated
(1) on the sides of the head of some amphibians
(2) at the reduced tail end of birds
(3) on either side of vagina in humans
(4) on either side of vas deferens in humans.

2003

109. During embryonic development, the establishment of polarity along anterior/posterior, dorsal/ventral or medial/lateral axis is called
(1) organiser phenomena
(2) axis formation
(3) anamorphosis
(4) pattern formation.

2002

110. What is true for cleavage?
(1) Size of embryo increases
(2) Size of cells decreases
(3) Size of cells increases
(4) Size of embryo decreases

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2001

111. Which set is similar?
(1) Corpus luteum - Graafian follicles
(2) Sebum - Sweat
(3) Bundle of His - Pacemaker
(4) Vitamin B7 - Niacin

2000

112. Blastopore is the pore of
(1) archenteron
(2) blastocoel
(3) coelom
(4) alimentary canal.

1999

113. The middle piece of the sperm contains
(1) proteins
(2) mitochondria
(3) centriole
(4) nucleus.

1999

114. After ovulation Graafian follicle regresses into
(1) corpus artesia
(2) corpus callosum
(3) corpus luteum
(4) corpus albicans.

1997

115. In the fertile human female, approximately on which day of the menstrual cycle does ovulation take place?
(1) Day 14
(2) Day 18
(3) Day 1
(4) Day 8

1997, 1991

116. Fertilizin is a chemical substance produced from
(1) polar bodies
(2) middle piece of sperm
(3) mature eggs
(4) acrosome.

1997

117. In human beings, the eggs are
(1) mesolecithal
(2) alecithal
(3) microlecithal
(4) macrolecithal.

1995

118. The mammalian corpus luteum produces
(1) luteotrophic hormone
(2) luteinising hormone
(3) estrogen
(4) progesterone.

1995

119. In an egg, the type of cleavage is determined by
(1) the amount and distribution of yolk
(2) the number of egg membranes
(3) the shape and size of the sperm
(4) the size and location of the nucleus.

1994

120. In the 28 day human ovarian cycle, the ovulation takes place typically on
(1) day 14 of the cycle
(2) day 28 of the cycle
(3) day 1 of the cycle
(4) day 5 of the cycle.

1994

121. What is true about cleavage in the fertilised egg in humans?
(1) It starts while the egg is in fallopian tube.
(2) It starts when the egg reaches uterus.
(3) It is meroblastic.
(4) It is identical to the normal mitosis.

1994

122. The extra embryonic membranes of the mammalian embryo are derived from
(1) trophoblast
(2) inner cell mass
(3) formative cells
(4) follicle cells.

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1993

123. Male hormone is produced in the testis by cells of
(1) Sertoli (2) epithelial
(3) spermatocytes (4) Leydig.

1993

124. Termination of gastrulation is indicated by
(1) obliteration of blastocoel
(2) obliteration of archenteron
(3) closure of blastopore
(4) closure of neural tube.

1993

125. In telolecithal egg the yolk is found
(1) all over the egg
(2) on one side
(3) both the sides
(4) centre.

1993

126. Acrosome reaction in sperm is triggered by
(1) capacitation
(2) release of lysin
(3) influx of NA^+
(4) release of fertilizin.

1992

127. Meroblastic cleavage is a division which is
(1) horizontal
(2) partial/parietal
(3) total
(4) spiral.

1992

128. Blastopore is
(1) opening of neural tube
(2) opening of gastrocoel
(3) future anterior end of embryo
(4) found in blastula.

1992

129. Eye lens is formed from
(1) ectoderm
(2) mesoderm
(3) endoderm
(4) ectoderm and mesoderm.

1991

130. Location and secretion of Leydig's cells are
(1) liver-cholesterol
(2) ovary-estrogen
(3) testis-testosterone
(4) pancreas-glucagon.

1991

131. During cleavage, what is true about cells?
(1) Nucleocytoplasmic ratio remains unchanged.
(2) Size does not increase.
(3) There is less consumption of oxygen.
(4) The division is like meiosis.

1991

132. Freshly released human egg has
(1) one Y-chromosome
(2) one X-chromosome
(3) two X-chromosome
(4) one X-chromosome and one Y-chromosome.

1990

133. How many sperms are formed from a secondary spermatocyte?
(1) 4
(2) 8
(3) 2
(4) 1

1990

134. Sperm and egg nuclei fuse due to
(1) base pairing of their DNA and RNA
(2) formation of hydrogen bonds
(3) mutual attraction due to differences in electrical charges
(4) attraction of their protoplasts.

1990

135. Gonads develop from embryonic
(1) ectoderm
(2) endoderm
(3) mesoderm
(4) both mesoderm and endoderm.

1989

136. Egg is liberated from ovary in
(1) secondary oocyte stage
(2) primary oocyte stage
(3) oogonial stage
(4) mature ovum stage.

1989

137. Cells become variable in morphology and function in different regions of the embryo. The process is
(1) differentiation
(2) metamorphosis
(3) organisation
(4) rearrangement.

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59. (1) urethra
The human male anatomy features a shared pathway for both the reproductive and excretory systems. The urethra originates from the urinary bladder and passes through the penis. It serves as the terminal duct that transports urine from the bladder during urination and also carries semen, containing sperm and glandular secretions, during ejaculation. Thus, it performs dual physiological roles in males.

60. (2) progesterone
After ovulation, the remains of the ruptured Graafian follicle transform into a temporary endocrine structure called the corpus luteum. Its primary physiological function is to produce and secrete high levels of the hormone progesterone. Progesterone is crucial for maintaining the thickened endometrial lining of the uterus, which is necessary for the successful implantation of an embryo and the continuation of pregnancy.

61. (3) High level of hCG stimulates the synthesis of estrogen and progesterone.
During early pregnancy, the developing placenta secretes human chorionic gonadotropin. This hormone is vital because it mimics the action of luteinizing hormone, ensuring the survival of the corpus luteum in the ovary. The persistent corpus luteum continues to secrete high levels of estrogen and progesterone, which maintain the uterine lining and prevent menstruation, thereby supporting the growth of the developing embryo.

62. (2) Spermatogonia, spermatocytes, spermatids, spermatozoa
Spermatogenesis is the sequential process of male gamete production within the seminiferous tubules. It begins with the diploid spermatogonia, which divide and differentiate into primary and secondary spermatocytes. These cells undergo meiosis to produce haploid spermatids. Finally, through the process of spermiogenesis, these circular spermatids undergo structural changes to transform into mature, motile spermatozoa, ready for transport and eventual successful fertilization.

63. (1) B - Corpus luteum - Secretes progesterone
The human ovary contains various structures at different stages of the menstrual cycle. The corpus luteum is a temporary endocrine gland formed from the ruptured follicle after ovulation has occurred. Its most critical role is the secretion of progesterone, which prepares and maintains the uterine lining for potential pregnancy. This hormonal production is essential for supporting the early stages of embryonic development.

64. (3) progesterone
The thickness of the endometrial lining in the uterus is primarily maintained by the hormone progesterone, which is secreted by the corpus luteum. If fertilization does not take place, the corpus luteum degenerates, leading to a sharp decline in progesterone levels. Without this hormonal support, the endometrium cannot be maintained and begins to disintegrate, resulting in the menstrual flow.

65. (2) Due to the genetic make up of the particular sperm which fertilises the egg.
In humans, sex is determined by the specific type of sex chromosome carried by the male gamete. While all female eggs contain a single X chromosome, male sperm cells can carry either an X or a Y chromosome. If a sperm with an X chromosome fertilizes the egg, the child will be female; if a sperm with a Y chromosome fertilizes, the child will be male.

66. (2) Secretes oxytocin during parturition
The placenta performs multiple vital functions, including supplying oxygen and nutrients to the embryo and removing carbon dioxide and nitrogenous wastes. It also secretes various hormones like estrogen and progesterone to maintain pregnancy. However, the release of oxytocin, which induces uterine contractions during labor, is the responsibility of the maternal posterior pituitary gland, not the placental tissue itself.

67. (4) oxytocin from maternal pituitary.
The process of childbirth is initiated by the fetal ejection reflex, which involves mild uterine contractions triggered by the fully developed fetus and the placenta. These initial signals act on the mother's hypothalamus, stimulating the posterior pituitary gland to release the hormone oxytocin. Oxytocin then causes stronger uterine contractions, creating a positive feedback loop that eventually leads to expulsion.

68. (4) androgens.
Leydig cells, also known as interstitial cells, are located in the connective tissue spaces between the seminiferous tubules in the human testes.

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systems are established by twelve weeks. Fetal movements and head hair development occur during the fifth month, indicating significant progress in the growth and maturation of the developing fetus.

13. (3) C → E → A → D → B
Milk produced in the mammary alveoli travels through a specific glandular network. From the alveoli, it flows into mammary tubules, which join to form mammary ducts. Several ducts converge into a wider section called the mammary ampulla. Finally, the milk enters the lactiferous duct, through which it is ejected during nursing, completing the essential physiological transport pathway.

14. (1) A-II, B-III, C-IV, D-I
The female external genitalia include various structures with distinct characteristics. The mons pubis is a fatty tissue cushion covered by skin and pubic hair. Labia majora are fleshy folds surrounding the vaginal opening. The clitoris is a small, sensitive finger-like structure. The hymen is a thin membrane that often partially covers the opening of the vagina within the vestibule.

15. (3) Statement I is true but Statement II is false.
The hymen is a thin membrane partially covering the vaginal opening. While it often tears during the first instance of sexual intercourse, it can also be broken by physical activities like cycling, horseback riding, or sudden sports movements. Therefore, the presence or absence of this membrane is not considered a scientifically reliable indicator of a female's past sexual experience.

16. (1) Uterine fundus
The fallopian tube, or oviduct, consists of three main anatomical regions: the funnel-shaped infundibulum with fimbriae, the wide ampulla, and the narrow isthmus connected to the uterus. The uterine fundus, however, is the rounded upper portion of the uterus itself, located above the entry points of the tubes, and is not part of the human oviduct's internal anatomy.

17. (4) ICSH, Leydig's cells, Sertoli cells, Spermatogenesis.
Gonadotropin-releasing hormone stimulates the anterior pituitary to secrete luteinizing hormone and follicle-stimulating hormone. Luteinizing hormone, also known as interstitial cell-stimulating hormone, acts on Leydig cells to produce androgens, driving sperm formation. Simultaneously, follicle-stimulating hormone targets Sertoli cells, which secrete essential factors that facilitate the final transformation process of spermatids into mature spermatozoa, completing the process of spermatogenesis.

18. (3) Both A and R are correct and R is the correct explanation of A.
In a standard twenty-eight-day menstrual cycle, ovulation typically occurs around the midpoint, specifically on the fourteenth day. This process is triggered by a sudden, rapid increase in the levels of luteinizing hormone, commonly referred to as the LH surge. This hormonal peak induces the mature Graafian follicle to rupture, releasing the secondary oocyte into the fallopian tube for fertilization.

NODIA

19. (4) A is false but R is true.
Follicle-stimulating hormone primarily targets the growing ovarian follicles in females to promote their development and estrogen secretion. In males, however, it acts on Sertoli cells, while luteinizing hormone stimulates the Leydig cells to produce androgens. While it is true that follicles secrete estrogen and interstitial cells produce androgens, the claim regarding hormone targets is biologically incorrect in males.

20. (1) A-III, B-IV, C-I, D-II
Human reproduction involves specialized structures and processes. Parturition is the delivery of the fetus, initiated by the fetal ejection reflex. The placenta acts as a temporary endocrine gland, secreting human chorionic gonadotropin to maintain pregnancy. Colostrum, the initial milk, provides essential antibodies to newborns for immunity. Fimbriae are finger-like projections of the fallopian tube that collect the released ovum.

21. (1) Both A and R are correct and R is the correct explanation of A.
Doctors strongly recommend breastfeeding during the initial growth period to ensure infant health. This is because the mother produces colostrum during the first few days of lactation. This fluid is exceptionally rich in antibodies, particularly immunoglobulin A, which provide essential passive immunity. These antibodies help the newborn develop resistance against

various infections while their own immune system gradually matures.

22. (3) Both Statement I and Statement II are true.
The male reproductive system includes the vas deferens, which joins with the duct from the seminal vesicle to form the ejaculatory duct, facilitating sperm transport. In the female system, the cervix contains a narrow cavity called the cervical canal. This canal, together with the vaginal passage, forms the birth canal, which serves as the pathway during natural childbirth.

23. (2) Statement I is incorrect but statement II is true.
During oogenesis, a primary follicle develops into a secondary follicle by adding more granulosa layers and a theca. However, the fluid-filled cavity known as the antrum is a characteristic feature of the tertiary follicle, not the secondary one. Ovulation involves the subsequent rupture of the fully mature Graafian follicle, which releases the secondary oocyte from the ovary into the tube.

24. (3) (B), (E), (A), (C), (D)
The hormonal regulation of gametogenesis begins with the hypothalamus releasing gonadotropin-releasing hormone. This triggers the anterior pituitary to secrete gonadotropins, namely LH and FSH. Luteinizing hormone then stimulates Leydig cells to produce androgens, which drive the process of spermatogenesis. Simultaneously, follicle-stimulating hormone acts on the Sertoli cells to support the final transformation of spermatids into functional, mature sperm cells.

25. (2) A, C and D only
Reproductive cycles vary across mammalian species, with non-primates exhibiting an oestrus cycle while primates undergo a menstrual cycle. In humans, this cycle begins at puberty with menarche and terminates at menopause. Cyclic menstruation is a reliable indicator of reproductive health, and its absence often serves as an early sign of pregnancy, reflecting the dynamic hormonal changes occurring within.

26. (4) Both (A) and (R) are true but (R) is not the correct explanation of (A).
The endometrium is the internal lining of the uterus essential for the successful implantation of a blastocyst during pregnancy. In a regular menstrual cycle where fertilization does not occur, the corpus luteum ceases its hormonal production and degenerates. This drop in progesterone levels leads to the breakdown of the endometrial lining, resulting in menstruation, rather than supporting an embryo.

27. (3) Statement I is correct but Statement II is incorrect
Spermiogenesis is the specific developmental process where non-motile, circular spermatids undergo structural transformations to become mature, motile spermatozoa. This is distinct from the earlier stages of spermatogenesis. Once fully formed, these spermatozoa are released from the Sertoli cells into the lumen of the seminiferous tubules, a physiological event specifically referred to as spermiation, completing the intratesticular developmental phase.

28. (4) (B), (C) and (E) only
Spermatogenesis and oogenesis differ significantly in their timing and mechanics. Unlike the female process, male gametogenesis begins only at puberty and involves a stem cell population that undergoes continuous division. Furthermore, in males, the final differentiation into mature, motile spermatozoa occurs after meiosis is fully completed. Oogenesis, conversely, starts before birth and does not follow this specific developmental pattern.

29. (2) Embryonic development stage
Oogenesis is the complex process of female gamete formation. Unlike males, who begin producing sperm at puberty, females initiate this process during their embryonic development. By the time a female fetus is born, millions of oogonia have already started meiosis and are arrested at the prophase-I stage, remaining in this state until the onset of puberty and hormonal stimulation.

30. (1) zona pellucida
The mammalian egg is surrounded by several protective layers. The zona pellucida is a transparent, acellular glycoprotein membrane situated between the plasma membrane and the corona radiata. This layer contains specific sperm-binding receptors that facilitate the attachment of a sperm cell. Upon binding, the acrosome reaction is triggered, allowing the sperm to penetrate and successfully fertilize the mature egg cell.

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31. (3) Corpus luteum
During pregnancy, various hormones are secreted to facilitate fetal development and eventual delivery. Relaxin is one such hormone produced during the later stages of pregnancy. In humans, it is primarily secreted by the corpus luteum in the ovary. Relaxin helps soften the pelvic ligaments and dilate the cervix, thereby preparing the maternal body for the physical process of parturition.

32. (1) Release of prolactin
Parturition is a complex neuroendocrine process triggered by signals from the fully developed fetus and placenta. It involves an increase in the estrogen-to-progesterone ratio, the synthesis of prostaglandins, and the release of oxytocin from the maternal pituitary to induce uterine contractions. However, prolactin is primarily responsible for milk production after birth and is not involved in initiating the labor process.

33. (4) at the time of fusion of a sperm with an ovum.
In human females, the second meiotic division of the secondary oocyte is uniquely arrested at the metaphase stage. This division is only completed when a sperm cell successfully penetrates the zona pellucida and makes contact with the oocyte's plasma membrane. This triggers the completion of meiosis, resulting in the formation of a haploid ootid and the second polar body.

34. (1) High concentration of Estrogen
Ovulation is governed by complex feedback mechanisms between the ovaries and the pituitary gland. As the Graafian follicle matures, it secretes increasing amounts of estrogen. This high concentration of estrogen exerts positive feedback on the hypothalamus and pituitary, triggering a massive surge in luteinizing hormone. It is this LH surge that ultimately causes the mature follicle to rupture and release.

35. (4) (A)-(ii), (B)-(iii), (C)-(iv), (D)-(i)
Human reproductive anatomy involves various tissues with specialized secretory roles. The placenta produces human chorionic gonadotropin to maintain the pregnancy. The zona pellucida acts as a protective glycoprotein layer around the ovum. In males, bulbourethral glands secrete fluids for the lubrication of the penis, while Leydig cells located in the interstitial spaces of the testes produce steroid hormones called androgens.

36. (3) Seminiferous tubules → Rete testis → Vasa efferentia → Epididymis → Vas deferens → Ejaculatory duct → Urethra → Urethral meatus
Sperm cells follow a precise anatomical route from their site of production to ejaculation. They are first formed in the seminiferous tubules, then pass through the rete testis and vasa efferentia into the epididymis for storage. Subsequently, they travel via the vas deferens to the ejaculatory duct, finally entering the urethra to be expelled through the urethral meatus during ejaculation.

37. (4) both FSH and LH levels are low in the luteal phase.
Following ovulation, the ruptured follicle transforms into the corpus luteum, which secretes high levels of progesterone and estrogen. These hormones exert strong negative feedback on the hypothalamus and anterior pituitary gland. This results in a significant reduction in the levels of follicle-stimulating hormone and luteinizing hormone, preventing the development of any new follicles during the luteal phase.

38. (2) after entry of sperm but before fertilisation
The second meiotic division in human females is arrested at metaphase II and only resumes upon the entry of a sperm cell. Once the sperm penetrates the secondary oocyte, it triggers the completion of this division. This results in the extrusion of the second polar body just before the male and female nuclei fuse to complete the fertilization process and zygote formation.

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39. (4) in spermiogenesis spermatozoa are formed, while in spermiation spermatozoa are released from Sertoli cells into the cavity of seminiferous tubules.
Spermiogenesis is the morphological transformation where spherical spermatids develop into specialized, elongated spermatozoa with a head and tail. In contrast, spermiation is the final stage of this process where mature spermatozoa are detached and released from the Sertoli cells into the lumen of the seminiferous tubules. Thus, one refers to cellular development, while the other describes tissue release.

40. (3) A-(ii), B-(iii), C-(i)
The human menstrual cycle consists of several distinct phases regulated by hormones. The

follicular phase, or proliferative phase, involves the regrowth of the endometrial lining. Following ovulation, the cycle enters the luteal or secretory phase, where the endometrium thickens further to prepare for potential implantation. If fertilization fails, menstruation occurs, characterized by the breakdown and shedding of the endometrial tissue.

41. (3) hCG, hPL, progestogens, estrogens
The placenta functions as an essential endocrine organ during pregnancy, producing several vital hormones. It secretes human chorionic gonadotropin to maintain the corpus luteum and human placental lactogen for fetal growth. Additionally, the placenta produces progestogens and estrogens to support the uterine environment. Other hormones like relaxin are primarily produced by the ovary, not the placenta, in late pregnancy.

42. (1) ectoderm and mesoderm
The amnion is one of the four extra-embryonic membranes that surround and protect the developing embryo in mammals. It forms a fluid-filled sac called the amniotic cavity, which prevents embryonic desiccation. Developmentally, the amnion is derived from the inner ectodermal layer and the outer somatic mesodermal layer, which fold together during the early stages of embryonic growth and morphogenesis.

43. (3) female reproductive tract
Capacitation is a crucial physiological maturation process that spermatozoa must undergo before they can successfully fertilize an egg. While sperm are produced and stored in the male system, they only achieve full functional maturity within the female reproductive tract. This process involves biochemical changes in the sperm membrane and increased motility, typically occurring as the sperm travel through the oviducts.

44. (1) Rete testis → Efferent ductules → Epididymis → Vas deferens
Sperm cells are produced in the seminiferous tubules of the testes. From there, they enter the rete testis, which is a network of tubules. They then travel through the efferent ductules, or vasa efferentia, to reach the epididymis, where they undergo further maturation and storage. Finally, the sperm move into the vas deferens to be transported toward the urethra for ejaculation.

45. (3) estrogen and progesterone
The secretion of gonadotropin-releasing hormone from the hypothalamus is regulated by a feedback mechanism involving ovarian steroids. Throughout the menstrual cycle, varying levels of circulating estrogen and progesterone act on the hypothalamus to adjust the frequency and amplitude of GnRH pulses. These adjustments, in turn, control the release of LH and FSH from the pituitary, driving the different cycle phases.

46. (1) LH and FSH decrease gradually during the follicular phase.
During the follicular phase of the menstrual cycle, the levels of luteinizing hormone and follicle-stimulating hormone do not decrease; instead, they gradually increase. This rise is necessary to stimulate the growth of ovarian follicles and the secretion of estrogen. The cycle culminates in a sharp peak of these hormones, particularly LH, which is essential for triggering the process of ovulation.

47. (4) Is produced by granulosa cells in ovary and inhibits the secretion of FSH
Inhibin is a peptide hormone involved in the negative feedback regulation of the reproductive system. In females, it is primarily produced by the granulosa cells of the ovarian follicles. Its main function is to selectively inhibit the secretion of follicle-stimulating hormone from the anterior pituitary gland. This helps regulate the number of developing follicles during each menstrual cycle, ensuring proper balance.

48. (4) the ovum and sperms are transported simultaneously to ampullary-isthmic junction of the fallopian tube.
For successful fertilization in humans, it is essential that both the mature ovum and the viable sperm arrive at the same location at the same time. This critical meeting point is the ampullary-isthmic junction within the fallopian tube. Because the ovum and sperm remain viable for only a limited duration, simultaneous transport to this specific region is required for pregnancy.

49. (2) A-(iii), B-(iv), C-(i), D-(ii)
Biological structures have specific associations within the reproductive system. The mons pubis is a component of the female external genitalia. An antrum is the characteristic fluid-filled cavity found in a mature Graafian follicle. During early

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development, the trophectoderm is the outer layer of the blastocyst essential for embryo formation and implantation. Nebenkern refers to the specialized mitochondrial arrangement in sperm.

50. (2) placenta
The placenta is a unique temporary organ that facilitates nutrient and waste exchange between the mother and the developing fetus. It also acts as an endocrine gland by synthesizing and secreting several vital hormones. These include human chorionic gonadotropin, human placental lactogen, estrogen, and progesterone. These hormones are essential for maintaining the pregnancy and supporting various physiological changes in the mother.

51. (3) uterus
Medical terminology often uses specific suffixes to denote surgical procedures. The suffix "-ectomy" refers to the surgical removal of a body part. In the context of female reproductive health, a hysterectomy is the surgical procedure performed to remove the uterus. This operation may be necessary to treat various conditions, such as uterine fibroids, endometriosis, or certain types of reproductive cancers.

52. (2) Zona pellucida
An antral follicle contains several layers surrounding the developing oocyte. While the stroma, granulosa, and theca interna are composed of living cells, the zona pellucida is distinctly different. It is an acellular, transparent membrane made of glycoproteins secreted by the oocyte and surrounding follicular cells. This layer remains around the egg until it eventually implants in the uterine wall after fertilization.

53. (1) Spermatogonia
Gametogenesis involves a series of cell divisions that reduce the chromosome number. Spermatogonia are the undifferentiated germ cells found in the seminiferous tubules; they are diploid, meaning they contain two sets of chromosomes. In contrast, other cells like primary and secondary polar bodies and spermatids are the products of meiotic divisions and are haploid, containing only a single set of chromosomes.

54. (3) Decrease in estradiol
Ovulation is the process where a mature follicle ruptures to release an egg. It is preceded by the full development of the Graafian follicle and a significant surge in luteinizing hormone. During this time, estradiol levels actually reach their peak, rather than decreasing, to trigger the hormonal surge. The event culminates in the release of the secondary oocyte into the oviduct.

55. (4) fertilisation.
In human females, the process of oogenesis is a discontinuous one. The secondary oocyte is released from the ovary having completed the first meiotic division, but it remains arrested in the metaphase of the second meiotic division. This division is only successfully completed when a sperm cell makes contact with and enters the oocyte, a biological process known as fertilization.

56. (3) sperm before fertilisation
Capacitation describes the series of physiological and biochemical changes that occur in spermatozoa after they have been deposited into the female reproductive tract. These changes are essential for the sperm to gain the ability to fertilize an egg. The process involves alterations to the sperm cell membrane and an increase in motility, occurring naturally as the sperm move toward the ovum.

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57. (4) implantation of embryo at site other than uterus.
In a normal pregnancy, a fertilized egg travels through the fallopian tube and attaches itself to the endometrial lining of the uterus. An ectopic pregnancy occurs when the embryo implants and begins to grow in a location outside the uterine cavity. The most common site for this abnormal implantation is within the fallopian tube, which cannot support a developing fetus.

58. (2) Release of prolactin
The initiation of parturition, or childbirth, is a complex process driven by several hormonal changes. Key components include the release of oxytocin, which stimulates uterine contractions, the synthesis of prostaglandins, and a shift in the estrogen-to-progesterone ratio. Prolactin, however, is a hormone primarily involved in the development of mammary glands and the stimulation of milk production after the baby is born.

ANSWERS

1. (3) flagellar movement
A sperm has a long tail (flagellum) whose whip-like beating propels the sperm forward through fluid. This flagellar movement enables the sperm to swim towards the ovum for fertilisation.

2. (2) Infundibulum
The infundibulum is the funnel-shaped opening of the fallopian tube in the female reproductive system. Vasa efferentia, rete testis and epididymis are all parts of the male reproductive system that carry and store sperm.

3. (2) LH
The human placenta secretes hCG, human placental lactogen, estrogen and progesterone to maintain pregnancy. Luteinising hormone (LH) is secreted by the anterior pituitary gland, not the placenta.

4. (1) zona pellucida
At ovulation, the secondary oocyte is surrounded by a transparent glycoprotein layer called the zona pellucida, lying beneath the outer corona radiata. The zona pellucida plays a role in sperm binding and fertilisation.

5. (1) Statement I is correct but Statement II is incorrect
Ovulation is triggered by the LH surge, which ruptures the Graafian follicle and releases the ovum, so Statement I is correct. After ovulation the ruptured follicle forms the corpus luteum, which secretes large amounts of progesterone, not estrogen, so Statement II is incorrect.

6. (2) C and E only
Secondary spermatocytes undergo the second meiotic division to form haploid spermatids (C correct), and spermatids transform into spermatozoa by spermiogenesis (E correct). Spermatogonia divide mitotically not always meiotically (A wrong), primary spermatocytes divide meiotically (B wrong), and spermatids do not divide by mitosis (D wrong).

7. (2) A-II, B-III, C-IV, D-I
Foetal movement and head hair appear around 20 weeks (II). Limbs and digits develop at about 8 weeks (III). External genital organs develop around 12 weeks (IV). Fine body hair, separated eyelids and eyelashes appear by about 24 weeks (I). This gives the match A-II, B-III, C-IV, D-I.

8. (3) C, A, B, D
Around the ovum, the outermost layer is the corona radiata, followed inward by the zona pellucida, then the perivitelline space, and finally the plasma membrane of the ovum. Hence the correct order from outer to inner is C (corona radiata), A (zona pellucida), B (perivitelline space), D (plasma membrane).

9. (3) A-IV, B-III, C-I, D-II
The human sperm consists of four distinct regions with specific functions. The head contains the haploid nucleus housing genetic material. The middle piece is packed with mitochondria that provide energy for swimming. The acrosome at the tip of the head carries enzymes essential for penetrating the egg. Finally, the tail ensures sperm motility and movement toward the target.

10. (4) menarche.
The initiation of the menstrual cycle in human females marks the onset of puberty. This first occurrence of menstruation is termed menarche. It signifies the functional maturation of the reproductive system and the beginning of the reproductive phase of life. In contrast, the permanent cessation of menstrual cycles in older females is known as menopause.

11. (3) A and B are true.
Oogenesis initiates during fetal development, whereas spermatogenesis begins only at puberty. In males, the transition from the first to the second meiotic division occurs rapidly within the testes. In females, however, the first meiotic division is completed just before ovulation, followed by a lengthy pause until fertilization occurs, creating a significant developmental time gap between the meiotic stages.

12. (2) A, C, D and E Only
Human embryonic development follows a specific chronological sequence. The heart is the first organ to form after one month. Limbs and digits appear by the second month, and major organ

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Their primary function is to synthesize and secrete male sex hormones, collectively known as androgens. The most prominent and important of these hormones is testosterone, which is essential for stimulating spermatogenesis and maintaining male secondary sexual characteristics.

69. (1) Sperm is viable for only up to 24 hours.
The viability and survival of mammalian sperm are influenced by several factors within the reproductive tract. While sperm generally remain active and capable of fertilization for forty-eight to seventy-two hours, their motility is a key indicator of their functional state. They thrive in an alkaline environment and must be present in a specific concentration within the semen to ensure successful fertilization.

70. (3) luteal phase and lasts for about 13 days
The menstrual cycle is divided into phases characterized by specific hormonal and physical changes. The secretory phase, which follows ovulation, is also known as the luteal phase because it is dominated by the activity of the corpus luteum. In a standard twenty-eight-day cycle, this phase is relatively constant in duration, typically lasting for approximately thirteen to fourteen days until menstruation.

71. (3) Blastocyst - Uterine wall
Following fertilization in the fallopian tube, the zygote undergoes multiple divisions as it moves toward the uterus. By the time it reaches the uterine cavity, it has developed into a hollow ball of cells called a blastocyst. This is the specific stage of embryonic development that eventually attaches to and implants within the nutrient-rich lining of the uterine wall for further growth.

72. (1) both placenta as well as fully developed fetus
Parturition, the act of giving birth, is a complex process initiated by specific biological signals. These signals originate from both the fully developed fetus and the placenta. This combined stimulus triggers the fetal ejection reflex, which subsequently induces the release of oxytocin from the maternal pituitary gland. This hormone then causes the powerful uterine contractions necessary to expel the fetus from the body.

73. (1) testes to epididymis
The male reproductive system contains a network of ducts that transport sperm. The vasa efferentia are small tubules that connect the rete testis within the testes to the epididymis, where sperm are stored and mature. If these specific ductules become blocked, the passage of gametes from the testes to the epididymis is halted, effectively preventing the sperm from moving further along.

74. (1) maintaining the scrotal temperature lower than the internal body temperature
In human males, the testes are located within the scrotum, an external pouch of skin. This anatomical arrangement is essential for effective spermatogenesis, as the production of viable sperm requires a temperature approximately two to two point five degrees Celsius lower than the normal internal body temperature. The scrotum acts as a thermoregulator, providing the cooler environment necessary for the testes.

75. (2) (III) Infundibulum, (IV) Fimbriae, (V) Cervix
The human female reproductive tract consists of several interconnected anatomical structures. The fallopian tube features a wide, funnel-like section called the infundibulum, which has finger-like projections known as fimbriae to capture the released egg. The uterus narrows at its lower end into the cervix, which connects to the vagina. Together, these parts facilitate the movement of gametes and eventual delivery.

76. (1) 14th day
The menstrual cycle is regulated by periodic changes in pituitary and ovarian hormones. At the midpoint of a typical twenty-eight-day cycle, there is a rapid and dramatic increase in the secretion of luteinizing hormone. This phenomenon, known as the LH surge, typically occurs on the fourteenth day and is the direct physiological trigger that induces the rupture of the Graafian follicle and ovulation.

77. (1) Secretions of acrosome helps one sperm enter cytoplasm of ovum through zona pellucida.
During fertilization, multiple sperm cells reach the outer layers of the ovum. However, only one sperm successfully penetrates the protective zona pellucida by releasing specialized enzymes from its acrosome. Once this sperm enters the cytoplasm of the egg, it induces a change in the membrane properties of the ovum, effectively blocking any additional sperm from entering and ensuring monospermic fertilization.

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78. (3) seminiferous tubules and provide nutrition to germ cells
Sertoli cells are specialized elongated cells found within the lining of the seminiferous tubules in the testes. Often referred to as nurse cells, their primary physiological role is to provide essential structural support and nutrition to the developing germ cells as they progress through various stages of spermatogenesis. These cells are also vital for regulating the hormonal environment necessary for sperm production.

79. (2) rete testis to vas deferens
The male reproductive duct system is a continuous pathway for sperm transport. Sperm pass from the seminiferous tubules into the rete testis, a network of interconnected channels. From the rete testis, several small ductules called vasa efferentia carry the sperm out of the testis and into the epididymis. From the epididymis, the sperm then continue their journey through the long vas deferens.

80. (1) fructose and calcium
Semen consists of sperm cells and a surrounding fluid known as seminal plasma. This plasma is primarily composed of secretions from the male accessory glands, including the seminal vesicles, prostate gland, and bulbourethral glands. It is specifically rich in fructose, which provides energy for sperm motility, as well as calcium ions and various enzymes that are essential for the survival of the sperm.

81. (1) Male accessory glands
The male accessory glands, consisting of the seminal vesicles, prostate, and bulbourethral glands, play a crucial role in reproduction. They secrete a specialized fluid called seminal plasma that mixes with sperm to form semen. This secretion is biologically significant because it contains high concentrations of fructose for energy, calcium for cellular signaling, and various enzymes necessary to facilitate the final fertilization process.

82. (2) infundibulum
The fallopian tube, or oviduct, is the structure that connects the ovaries to the uterus. It is composed of different regions, the narrowest being the isthmus and the widest being the ampulla. The section situated closest to the ovary is the infundibulum. This funnel-shaped part features finger-like projections called fimbriae, which help in capturing the egg cell released from the ovary.

83. (2) The sperm lysins in the acrosome dissolve the egg envelope facilitating fertilisation.
The acrosome is a cap-like structure located at the anterior end of the sperm head. It is derived from the Golgi apparatus and contains powerful hydrolytic enzymes known as sperm lysins. These enzymes are essential for fertilization because they chemically dissolve the protective outer layers of the egg, such as the zona pellucida. This action allows the sperm to penetrate the egg.

84. (2) until after the ovum has been penetrated by a sperm
Oogenesis in human females involves two distinct maturation divisions. The first meiotic division is completed just before ovulation. However, the resulting secondary oocyte begins the second meiotic division but remains arrested at the metaphase stage. This final maturation process is only triggered and completed once a sperm cell has successfully penetrated the oocyte's membrane, finally resulting in a haploid ovum.

85. (1) It has almost equal quantity of cytoplasm as an uncleaved zygote but much more DNA.
Following fertilization, the zygote undergoes a series of rapid mitotic divisions called cleavage. This process produces a solid ball of cells known as the morula. Because cleavage involves division without an overall increase in embryonic size, the morula contains roughly the same amount of cytoplasm as the original zygote. However, with each division, the total number of nuclei and DNA content increases.

86. (4) gets implanted in endometrium by the trophoblast cells.
As the early embryo develops into a blastocyst, it consists of an outer layer of cells called the trophoblast and an inner cell mass. The trophoblast cells are specialized for interaction with the maternal tissue. They facilitate the attachment and subsequent embedding of the blastocyst into the nutrient-rich endometrial lining of the uterus, a critical process known as implantation.

87. (2) Fifth month
Human prenatal development is marked by significant milestones at different stages of gestation. By the end of the first trimester, most

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major organ systems have formed. Significant changes continue into the second trimester, where fetal movements begin to occur. It is typically during the fifth month of pregnancy that these first movements are observed, along with the initial appearance of hair.

88. (2) oxytocin from maternal pituitary
The culmination of pregnancy leads to parturition, which is regulated by a complex neuroendocrine reflex. Initial signals for labor are generated by the mature fetus and the placenta, triggering the fetal ejection reflex. This reflex stimulates the mother's posterior pituitary gland to release the hormone oxytocin into the bloodstream. Oxytocin then acts on the uterine muscles to induce strong contractions for childbirth.

89. (4) fructose, calcium and certain enzymes.
Semen is composed of spermatozoa suspended in a liquid medium known as seminal plasma. This fluid is the combined secretion of the male accessory glands, which include the seminal vesicles, the prostate gland, and the bulbourethral glands. Seminal plasma provides a protective and nutrient-rich environment for the sperm, containing essential components such as fructose for energy and specialized enzymes.

90. (1) A-Vas deferens, B-Seminal vesicle, C-Prostate, D-Bulbourethral gland
The male reproductive system includes several interconnected ducts and accessory glands. The vas deferens is the long tube that carries sperm from the epididymis. The seminal vesicles are paired glands that contribute the majority of the fluid in semen. Located below the bladder, the prostate gland surrounds the urethra, while the small, paired bulbourethral glands provide lubrication during sexual arousal.

91. (1) spermatogonia - spermatocyte - spermatid - sperms
Spermatogenesis is the highly organized process of sperm production occurring within the seminiferous tubules. It begins with the division of diploid germ cells called spermatogonia. These develop into primary and then secondary spermatocytes through meiotic divisions. The resulting haploid cells are known as spermatids, which eventually undergo a morphological transformation to become the mature, motile spermatozoa that are eventually released.

92. (2) Secretory phase : Development of corpus luteum and increased secretion of progesterone
The menstrual cycle consists of coordinated changes in the ovaries and the uterus. Following ovulation, the cycle enters the secretory phase, which corresponds with the luteal phase of the ovary. During this time, the ruptured follicle transforms into the corpus luteum, which secretes high levels of progesterone. This hormone stimulates the further thickening and vascularization of the endometrium for implantation.

93. (4) Fertilisation of the ovum
Menstruation is the cyclic shedding of the endometrial lining that occurs when fertilization does not take place. If a mature egg is fertilized by a sperm cell, the resulting embryo implants in the uterus and begins to produce hormones like human chorionic gonadotropin. These signals prevent the degeneration of the corpus luteum, maintaining high progesterone levels and stopping the menstrual cycle.

94. (1) pattern of cleavage
Cleavage is the series of rapid mitotic divisions that occur in a zygote following fertilization. The specific pattern and rate of these divisions are heavily influenced by the amount and distribution of yolk within the egg. Yolk acts as a physical barrier to the cleavage furrows; therefore, eggs with different yolk concentrations will undergo either total or partial division.

95. (2) fully developed fetus and placenta
Parturition is the physiological process of delivering a baby, initiated by the fetal ejection reflex. This reflex is triggered by biochemical signals that originate from the fully developed fetus and the placenta. These signals induce mild uterine contractions, which then stimulate the maternal pituitary gland to release oxytocin. This creates a positive feedback loop of increasing contractions, leading to birth.

96. (4) secondary spermatocytes.
In the process of spermatogenesis, diploid primary spermatocytes undergo the first meiotic division. This is a reductional division that halves the chromosome number, resulting in the formation of two haploid cells known as secondary spermatocytes. These cells then quickly enter the second meiotic division to produce spermatids, which eventually transform

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known as fertilizin. This glycoprotein interacts with another substance called antifertilizin, which is present on the surface of the sperm head. This specific interaction ensures that only sperm from the same species can successfully recognize and fertilize the egg.

117. (2) alecithal
Animal eggs can be classified based on the amount of yolk they contain. In human beings and other placental mammals, the developing embryo receives its nutrients directly from the mother through the placenta. As a result, the eggs do not need to store large amounts of yolk for nourishment. Therefore, human eggs are described as alecithal, meaning they contain virtually no yolk.

118. (4) progesterone.
The corpus luteum is a temporary endocrine structure formed in the ovary after a mature follicle has released its egg. Its main biological function is the production and secretion of the steroid hormone progesterone. This hormone is essential for the reproductive process because it prepares the endometrium for the implantation of a fertilized egg and helps maintain the pregnancy.

119. (1) the amount and distribution of yolk
After fertilization, the zygote begins a series of rapid cell divisions called cleavage. The specific manner in which these divisions occur is primarily determined by two factors: the total amount of yolk stored within the egg and how that yolk is distributed. Yolk tends to slow down or prevent the formation of cleavage furrows, leading to different embryonic developmental patterns.

120. (1) day 14 of the cycle
The human ovarian cycle typically lasts for twenty-eight days and is divided into distinct phases. Ovulation is the central event of this cycle, occurring when a mature follicle ruptures to release an egg. In a standard cycle, this process happens approximately on day fourteen. This timing is critical because it marks the end of the follicular phase and the beginning phase.

121. (1) It starts while the egg is in fallopian tube.
Following the successful fertilization of an egg by a sperm cell in the ampulla, the resulting zygote begins its journey toward the uterus. During this transit, which takes several days, the zygote immediately initiates the process of cleavage. These initial mitotic divisions occur while the developing embryo is still moving through the fallopian tube, well before it reaches the cavity.

122. (1) trophoblast
In the early stages of mammalian development, the blastocyst consists of two primary cell populations. The inner cell mass is destined to become the embryo itself. In contrast, the outer layer of cells, known as the trophoblast, plays a fundamental role in establishing the connection with the mother. The trophoblast is the primary source from which the various extra-embryonic membranes are derived.

123. (4) Leydig.
Testosterone, the primary male sex hormone, is produced within the testes. Specifically, it is synthesized by a group of specialized endocrine cells known as Leydig cells, or interstitial cells. These cells are located in the small spaces between the seminiferous tubules. Their activity is stimulated by luteinizing hormone from the pituitary gland, which triggers the production and release of androgens.

124. (1) obliteration of blastocoel
Gastrulation is a major developmental phase where the single-layered blastula is reorganized into a multi-layered structure called the gastrula. As cells migrate inward to form the primitive gut, or archenteron, they gradually displace the existing fluid-filled cavity of the blastula. The completion of this process is typically indicated by the total obliteration of the blastocoel as the new embryonic layers.

125. (2) on one side
Eggs can be categorized based on the spatial distribution of the yolk they contain. In a telolecithal egg, the yolk is not distributed evenly throughout the cytoplasm; instead, it is concentrated heavily at one end, known as the vegetal pole. This unequal distribution causes the nucleus and the majority of the active cytoplasm to be shifted toward the opposite end.

126. (4) release of fertilizin.
The acrosome reaction is a critical step that allows a sperm cell to penetrate the protective layers of an egg. This reaction is triggered when the sperm comes into contact with the egg's outer environment. Specifically, the interaction

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midpoint of the cycle, typically on the fourteenth day. At this exact point, a surge in luteinizing hormone occurs, which triggers ovulation, marking the transition from the proliferative to the secretory phase.

107. (2) Prolactin
The human placenta is a vital temporary organ that produces several hormones to support and maintain pregnancy. It secretes human chorionic gonadotropin, human placental lactogen, estrogen, and progesterone. However, prolactin is not a product of the placenta; instead, it is primarily synthesized and secreted by the anterior pituitary gland to stimulate the development of mammary glands and milk production.

108. (3) on either side of vagina in humans
Bartholin's glands, also known as the greater vestibular glands, are two small secretory organs found in the female reproductive system. They are located on either side of the vaginal opening. Their primary physiological function is to secrete a lubricating fluid into the vestibule during sexual arousal, which helps reduce friction. These glands are homologous to the bulbourethral glands in males.

109. (4) pattern formation.
During the early stages of embryonic development, a complex process occurs where cells organize themselves into specific spatial arrangements. This involves the establishment of different body axes, such as anterior-posterior and dorsal-ventral, which determine the basic body plan. This fundamental developmental process is known as pattern formation. It ensures that tissues and organs develop in their correct locations and orientations.

110. (2) Size of cells decreases
Cleavage is a unique form of mitotic cell division that occurs in a newly formed zygote. During this process, the overall size of the embryo does not increase because the cells do not undergo a growth phase between divisions. Consequently, with each successive round of cleavage, the resulting daughter cells, known as blastomeres, become progressively smaller while the DNA content increases.

111. (1) Corpus luteum - Graafian follicles
The human reproductive cycle involves structures that are developmentally related. The Graafian follicle is the mature stage of a developing ovarian follicle that contains the egg. Following ovulation, the cells of the ruptured Graafian follicle transform into the corpus luteum, a temporary endocrine gland. Thus, these two structures represent different functional stages of the same follicular tissue within the ovary.

112. (1) archenteron
During the process of gastrulation in animal embryos, a major reorganization of cells occurs. This leads to the formation of a primitive gut cavity known as the archenteron. The external opening that connects this internal cavity to the outside of the embryo is called the blastopore. In different species, this pore eventually develops into either the mouth or the anus.

113. (2) mitochondria
A mature human sperm cell is divided into several specialized regions: the head, neck, middle piece, and tail. The middle piece is particularly important because it is densely packed with numerous spiral mitochondria. These organelles function as the powerhouse of the cell, generating the energy required to power the movement of the tail, thereby enabling the sperm to swim toward the egg.

114. (3) corpus luteum
Following the release of the secondary oocyte during ovulation, the remnants of the Graafian follicle do not simply disappear. Instead, under the influence of luteinizing hormone, the remaining follicular cells undergo a structural and functional change to form a yellowish glandular mass called the corpus luteum. This temporary organ plays a vital role in secreting progesterone to maintain the uterine lining.

115. (1) Day 14
In a healthy, fertile human female with a regular twenty-eight-day menstrual cycle, ovulation occurs with remarkable predictability. The process is typically centered at the midpoint of the cycle, which is day fourteen. At this time, a peak in the levels of luteinizing hormone triggers the release of the egg from the ovary, making it available for fertilization in the tube.

116. (3) mature eggs
Fertilization involves chemical communication between the egg and the sperm. Mature egg cells produce and secrete a specific chemical substance

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is liberated from the Graafian follicle while it is still in the secondary oocyte stage. At this point, the cell has completed the first meiotic division but is arrested in the metaphase of the second meiotic division. Maturation only concludes after fertilization occurs.

137. (1) differentiation

As an embryo develops, its constituent cells begin to undergo significant changes in their structural characteristics and physiological roles. This process, where initially identical cells become specialized to perform different functions in various regions of the body, is known as differentiation. It is a fundamental aspect of development that allows for the formation of distinct tissues and organs with highly specialized biological capabilities.

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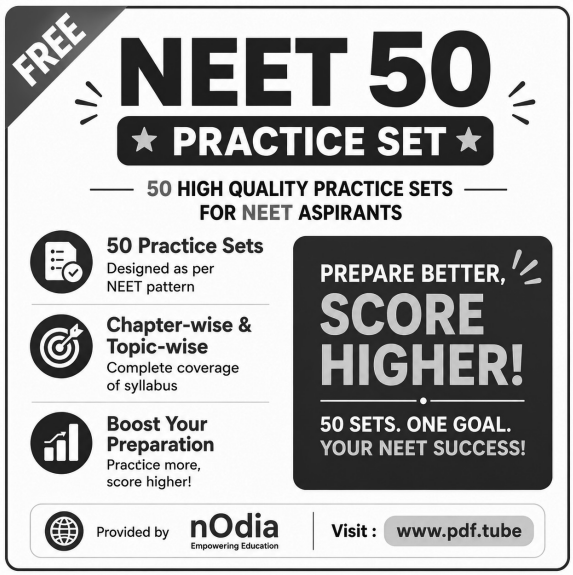

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between chemical substances like fertilizin, produced by the egg, and antifertilizin on the sperm surface initiates the release of essential enzymes.

127. (2) partial/parietal
Cleavage patterns in zygotes are determined by the quantity of yolk present. In eggs with a very large amount of yolk, such as those of birds or reptiles, the cleavage furrows cannot pass entirely through the dense yolk mass. As a result, only the small disc of active cytoplasm at the top undergoes division. This type of incomplete division is termed meroblastic cleavage.

128. (2) opening of gastrocoel
During the embryonic stage of gastrulation, a significant inward movement of cells occurs to form the primitive gut, also known as the gastrocoel or archenteron. The blastopore is the specific opening that connects this newly formed internal cavity to the exterior of the embryo. The fate of the blastopore varies among different animal groups, eventually becoming the mouth or anus.

129. (1) ectoderm
During embryonic development, the three primary germ layers—ectoderm, mesoderm, and endoderm—give rise to specific tissues and organs. The nervous system and many sensory structures originate from the outermost layer. Specifically, the lens of the eye is derived from the surface ectoderm. This process involves a complex induction between the developing brain and the overlying ectodermal tissue during morphogenesis.

130. (3) testis-testosterone
Leydig cells, also known as interstitial cells, are essential components of the male reproductive system. They are located within the testes, specifically in the interstitial tissue found between the seminiferous tubules. These cells function as an endocrine tissue, and their primary role is the synthesis and secretion of testosterone. This hormone is crucial for promoting sperm production and secondary sexual characteristics.

131. (2) Size does not increase.
Cleavage is a unique phase of early embryonic development characterized by rapid mitotic divisions of the zygote. One of the most defining features of this process is that there is no growth phase between successive divisions. Consequently, while the number of cells increases, the overall volume of the embryo remains constant. This means that the individual blastomeres do not increase.

132. (2) one X-chromosome
Human gametes are produced through the process of meiosis, which reduces the total number of chromosomes by half. Since female body cells possess two X chromosomes, every secondary oocyte produced during oogenesis will receive exactly one X chromosome. Therefore, a freshly released human egg always contains a single X chromosome as its sex chromosome, regardless of eventual fertilization.

133. (3) 2
In the male reproductive system, spermatogenesis involves two successive meiotic divisions. A primary spermatocyte undergoes the first meiotic division to produce two haploid secondary spermatocytes. Each of these secondary spermatocytes then undergoes the second meiotic division, which is an equational division. This process results in the formation of two spermatids from each secondary spermatocyte, which mature into sperm.

134. (4) attraction of their protoplasts.
Fertilization is a complex biological process that culminates in the fusion of male and female gametes. After the sperm successfully penetrates the egg, the two haploid nuclei, or pronuclei, must come together to form a diploid zygote. This final merging of genetic material is driven by the mutual attraction and movement of their respective protoplasts, ensuring the combination of DNA.

135. (3) mesoderm
The development of the vertebrate embryo involves the differentiation of three primary germ layers. Each layer is responsible for forming specific organ systems. The mesoderm, which is the middle germ layer, gives rise to several critical structures, including the muscular system, the circulatory system, and the excretory system. Notably, the gonads—the testes in males and ovaries in females—originate from mesoderm.

136. (1) secondary oocyte stage
In human females, the process of ovulation does not release a fully mature ovum. Instead, the egg

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2024

7. Which of the following is not a natural / traditional contraceptive method ?
(1) Coitus interruptus
(2) Periodic abstinence
(3) Lactational amenorrhea
(4) Vaults

RE-EXAM 2024

8. Following is the list of STDs. Select the diseases which are not completely curable.
A. Genital warts
B. Genital herpes
C. Syphilis
D. Hepatitis-B
E. Trichomoniasis
Choose the correct answer from the options given below.
(1) A and D only
(2) B and D only
(3) A and C only
(4) D and E only

Manipur NEET 2023

9. Which of the following statements are correct?
(A) Reproductive health refers to total well-being in all aspects of reproduction.
(B) Amniocentesis is legally banned for sex determination in India.
(C) "Saheli" a new oral contraceptive for females was developed in collaboration with ICMR (New Delhi).
(D) Amniocentesis is used to determine genetic disorders and survivability of foetus.
Choose the most appropriate answer from the options given below.
(1) (B) and (C) only
(2) (D) and (C) only
(3) (A), (B) and (D) only
(4) (A) and (C) only

2023

10. Given below are two statements: one is labelled as Assertion (A) : and the other is labelled as Reason (R).
Assertion (A) : Amniocentesis for sex determination is one of the strategies of Reproductive and Child Health Care Programme.
Reason (R) : Ban on amniocentesis checks increasing menace of female foeticide.
In the light of the above statements, choose the correct answer from the options given below:
(1) (A) is true but (R) is false.
(2) (A) is false but (R) is true.
(3) Both (A) and (R) are true and (R) is the correct explanation of (A).
(4) Both (A) and (R) are true and (R) is not the correct explanation of (A).

Manipur NEET 2023

11. Match List I with List II.

	List-I		List-II
A.	Non-medicated IUDs	I.	Multiload 375
B.	Copper releasing IUDs	II.	Rubber barrier
C.	Hormone releasing IUDs	III.	Lippes' loop
D.	Vaults	IV.	LNG-20

Choose the correct answer from the options given below.
(1) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)
(2) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)
(3) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(4) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)

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2023

12. Match List I with List II.

	List-I		List-II
A.	Vasectomy	I.	Oral method
B.	Coitus interruptus	II.	Barrier method
C.	Cervical caps	III.	Surgical method
D.	Saheli	IV.	Natural method

Choose the correct answer from the options given below:
(1) A-II, B-III, C-I, D-IV
(2) A-IV, B-II, C-I, D-III
(3) A-III, B-I, C-IV, D-II
(4) A-III, B-IV, C-II, D-I

Manipur NEET 2023

13. Which of the following sexually transmitted infections are completely curable?
(1) HIV infection and Trichomoniasis
(2) Syphilis and Trichomoniasis
(3) Hepatitis-B and Genital herpes
(4) Genital herpes and Genital warts

2023

14. Which one of the following common sexually transmitted diseases is completely curable when detected early and treated properly?
(1) Hepatitis-B
(2) HIV Infection

CHAPTER 22
Reproductive Health

2026 (RE-NEET)

1. Which of the following disease is not sexually transmitted?
(1) Gonorrhoea
(2) Genital warts
(3) Syphilis
(4) Tuberculosis

2026 (RE-NEET)

2. The method of directly injecting a sperm into ovum in assisted reproductive technology is called:
(1) Intra cytoplasmic sperm injection (ICSI)
(2) Embryo transfer (ET)
(3) Gamete intra fallopian transfer (GIFT)
(4) Zygote intra fallopian transfer (ZIFT)

2026 (CANCELLED)

3. Match List I with List II:
List I:
A. Progestasert
B. Multiload 375
C. Diaphragm
D. Saheli
List II:
I. Barrier made of rubber used by females
II. Oral contraceptive
III. Hormone releasing IUD
IV. Copper releasing IUD
Choose the correct answer from the options given below :
(1) A-III, B-IV, C-I, D-II
(2) A-IV, B-II, C-I, D-III
(3) A-IV, B-III, C-I, D- II
(4) A-III, B-IV, C-II, D-I

2026 (CANCELLED)

4. Choose the correct statement regarding GIFT to overcome infertility:
(1) Ova collected from a female donor are transferred to the uterus of an infertile female.
(2) Early embryos with up to 8 blastomeres are transferred to the uterus of an infertile female.
(3) Early embryos with up to 8 blastomeres are transferred into the fallopian tube of an infertile female.
(4) It is the transfer of an ovum collected from a donor into the fallopian tube of another female who cannot produce ovum but can provide suitable environment for fertilization and development.

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RE-EXAM 2024

5. Match List-I with List-II relating to examples of various kind of IUDs and barrier.

	List-I		List-II
A.	Copper releasing IUD	I.	Vaults
B.	Non-medicated IUD	II.	Multiload 375
C.	Contraceptive barrier	III.	LNG-20
D.	Hormone releasing IUD	IV.	Lippes loop

Choose the correct answer from the options given below.
(1) A-II, B-IV, C-III, D-I
(2) A-IV, B-III, C-I, D-II
(3) A-II, B-I, C-III, D-IV
(4) A-II, B-IV, C-I, D-III

2024

6. Match List I with List II.

	List-I		List-II
A.	Non-medicated IUD	I.	Multiload 375
B.	Copper releasing IUD	II.	Progestogens
C.	Hormone releasing IUD	III.	Lippes loop
D.	Implants	IV.	LNG-20

Choose the correct answer from the options given below.
(1) A-III, B-I, C-II, D-IV
(2) A-I, B-III, C-IV, D-II
(3) A-IV, B-I, C-II, D-III
(4) A-III, B-I, C-IV, D-II

into mature spermatozoa. This sequence ensures the production of haploid gametes.

97. (4) The menstrual fluid can easily clot.
Menstruation is the normal periodic discharge of blood and endometrial tissue from the uterus. During a typical cycle, about forty milliliters of blood is lost. At the end of the reproductive years, menopause is marked by a significant increase in gonadotropic hormones. Notably, menstrual fluid does not normally clot because it contains an enzyme called plasmin, which prevents clot formation.

98. (2) Amnion
The amnion is an extra-embryonic membrane that develops around the embryo in reptiles, birds, and mammals. It forms a sealed, fluid-filled sac known as the amniotic cavity. The amniotic fluid within this sac serves several critical functions: it acts as a shock absorber to protect the fetus from physical injury and provides a moist environment that effectively prevents embryonic desiccation.

99. (2) causes strong uterine contractions during parturition
Oxytocin is a peptide hormone synthesized in the hypothalamus and released by the posterior pituitary gland. In adult females, it plays a vital role during childbirth by stimulating the smooth muscles of the uterine wall. This leads to increasingly strong uterine contractions that are essential for the expulsion of the fetus. Additionally, oxytocin is involved in the milk-ejection reflex during breastfeeding.

100. (4) Graafian follicle
Following the release of the egg during ovulation, the remaining cells of the ruptured Graafian follicle undergo a transformation. They form a new, temporary endocrine structure known as the corpus luteum. This gland is responsible for secreting significant amounts of progesterone and some estrogen, which are essential for preparing the uterine lining for potential implantation and maintaining early stages of pregnancy.

101. (2) combination of estrogen and progesterone
The onset of menstruation is triggered by a sudden drop in the levels of ovarian hormones, particularly progesterone, when fertilization does not occur. By administering a combination of estrogen and progesterone, the hormonal levels in the bloodstream are maintained at a high level. This prevents the breakdown of the endometrial lining, thereby deferring the menstrual phase for as long as needed.

102. (2) FSH
Sertoli cells, located within the seminiferous tubules of the testes, are essential for supporting the development of sperm. Their activity is primarily regulated by follicle-stimulating hormone, which is secreted by the anterior pituitary gland. FSH binds to specific receptors on the Sertoli cells, stimulating them to produce various factors and proteins that are required for the completion of the spermatogenesis process.

103. (1) Progesterone
During the secretory phase of the menstrual cycle, the corpus luteum secretes high levels of progesterone, which maintains the thickened uterine lining. If the ovum is not fertilized, the corpus luteum eventually degenerates, causing a rapid withdrawal of progesterone. This sudden decline in hormone levels leads to the constriction of blood vessels in the endometrium, its subsequent breakdown, and menstruation.

104. (3) Estrogen secretion further increases.
In a typical menstrual cycle, if the released egg is not fertilized, the corpus luteum ceases its hormonal production and begins to disintegrate. This results in a sharp decline in the levels of both progesterone and estrogen. Therefore, it is highly unlikely for estrogen secretion to increase under these circumstances. The drop in these hormones eventually triggers the shedding of the endometrium.

105. (2) just opposite to the site of entry of sperm into ovum
The grey crescent is a specialized cytoplasmic region that appears in the eggs of certain amphibians, like frogs, immediately following fertilization. It forms on the side of the egg that is exactly opposite to the point where the sperm cell entered. This region is critical for future development, as it marks the site where the dorsal lip will form.

106. (4) at the end of the proliferative phase.
In a standard human menstrual cycle, the proliferative phase involves the repair and growth of the endometrial lining under the influence of estrogen. This phase concludes around the

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(3) Genital herpes
(4) Gonorrhoea

Manipur NEET 2023

15. Given below are two statements.
Statement I : Intra Cytoplasmic Sperm Injection (ICSI) is another specialised procedure of in-vivo fertilisation.
Statement II : Infertility cases due to inability of the male partner to inseminate female can be corrected by artificial insemination (AI).
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is correct but statement II is false.
(2) Statement I is incorrect but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

2022

16. Lippe's loop is a type of contraceptive used as:
(1) Cervical barrier
(2) Vault barrier
(3) Non-Medicated IUD
(4) Copper releasing IUD.

2022

17. Match list-I with list-II with respect to method of contraception and their respective actions.

	List-I		List-II
A.	Diaphragms	(i)	Inhibit ovulation and implantation
B.	Contraceptive pills	(ii)	Increase phagocytosis of sperm within uterus
C.	Intra Uterine devices	(iii)	Absence of menstrual cycle and ovulation following parturition
D.	Lactational amenorrhea	(iv)	They cover the cervix blocking the entry of sperms

Choose the correct answer from the options given below:
(1) (A)-(iv), (B)-(i), (C)-(iii), (D)-(ii)
(2) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii)
(3) (A)-(ii), (B)-(iv), (C)-(i), (D)-(iii)
(4) (A)-(iii), (B)-(ii), (C)-(i), (D)-(iv)

2021

18. Match List- I with List- II.

	List-I		List-II
(p)	Vaults	(i)	Entry of sperm through cervix is blocked
(q)	IUDs	(ii)	Removal of Vas deferens
(r)	Vasectomy	(iii)	Phagocytosis of sperms within the uterus
(s)	Tubectomy	(iv)	Removal of fallopian tube

Choose the correct answer from the options given below.
(1) (p)-(iii); (q)-(i); (r)-(iv); (s)-(ii)
(2) (p)-(iv); (q)-(ii); (r)-(i); (s)-(iii)
(3) (p)-(i); (q)-(iii); (r)-(ii); (s)-(iv)
(4) (p)-(ii); (q)-(iv); (r)-(iii); (s)-(i)

2021

19. Which one of the following is an example of hormone releasing IUD?
(1) Multiload 375
(2) CuT
(3) LNG-20
(4) Cu 7

2021

20. Veneral diseases can spread through
(A) using sterile needles
(B) transfusion of blood from infected person
(C) infected mother to fetus
(D) kissing
(E) inheritance
Choose the correct answer from the options given below.
(1) (A) and (C) only
(2) (A), (B) and (C) only
(3) (B), (C) and (D) only
(4) (B) and (C) only

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2020

21. Select the option including all sexually transmitted diseases.
(1) Gonorrhoea, Syphilis, Genital herpes
(2) Gonorrhoea, Malaria, Genital herpes
(3) AIDS, Malaria, Filaria
(4) Cancer, AIDS, Syphilis

2020

22. What are the potential drawbacks in adoption of the IVF method?

A. High fatality risk to mother
B. Expensive instruments and reagents
C. Husband/wife necessary for being donors
D. Less adoption of orphans
E. Not available in India
F. Possibility that the early embryo does not survive

Choose the correct answer from the options given below.

(1) A, B, C, D only
(2) A, B, C, E, F only
(3) B, D, F only
(4) A, C, D, F only

2020

23. In which of the following techniques, the embryos are transferred to assist those females who cannot conceive?

(1) ZIFT and IUT
(2) GIFT and ZIFT
(3) ICSI and ZIFT
(4) GIFT and ICSI

2019

24. Which of the following contraceptive methods involve a role of hormone?

(1) Pills, Emergency contraceptives, Barrier methods
(2) Lactational amenorrhea, Pills, Emergency contraceptives
(3) Barrier method, Lactational amenorrhea
(4) CuT, Pills, Emergency contraceptive

2019

25. Select the hormone-releasing Intra-Uterine Devices.

(1) Lippes Loop, Multiload 375
(2) Vaults, LNG-20
(3) Multiload 375, Progestasert
(4) Progestasert, LNG-20

Odisha NEET 2019

26. Which of the following is a correct statement?

(1) IUDs once inserted need not be replaced.
(2) IUDs are generally inserted by the user herself.
(3) IUDs increase phagocytosis of sperms in the uterus.
(4) IUDs suppress gametogenesis.

2019

27. Which of the following sexually transmitted diseases is not completely curable?

(1) Chlamydiasis
(2) Gonorrhoea
(3) Genital warts
(4) Genital herpes

2018

28. The contraceptive 'Saheli'

(1) blocks estrogen receptors in the uterus, preventing eggs from getting implanted
(2) increases the concentration of estrogen and prevents ovulation in females
(3) is an IUD
(4) is a post-coital contraceptive.

2017

29. The function of copper ions in copper releasing IUDs is

(1) they inhibit gametogenesis
(2) they make uterus unsuitable for implantation
(3) they inhibit ovulation
(4) they suppress sperm motility and fertilising capacity of sperms.

2017

30. Match the following sexually transmitted diseases (column I) with their causative agent (column II) and select the correct option.

	Column I (Diseases)		Column II (Causative Agents)
A.	Gonorrhoea	(i)	HIV
B.	Syphilis	(ii)	Neisseria
C.	Genital warts	(iii)	Treponema
D.	AIDS	(iv)	Human papilloma virus

(1) A-(iii); B-(iv); C-(i); D-(ii)
(2) A-(iv); B-(ii); C-(iii); D-(i)
(3) A-(iv); B-(iii); C-(ii); D-(i)
(4) A-(ii); B-(iii); C-(iv); D-(i)

2017

31. In case of a couple where the male is having a very low sperm count, which technique will be suitable for fertilisation?

(1) Gamete Intracytoplasmic Fallopian Transfer
(2) Artificial Insemination
(3) Intracytoplasmic sperm injection
(4) Intrauterine transfer

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NEET-I 2016

32. In context of amniocentesis, which of the following statements is incorrect?
(1) It can be used for detection of Down's syndrome.
(2) It can be used for detection of cleft palate.
(3) It is usually done when a woman is between 14-16 weeks pregnant.
(4) It is used for prenatal sex determination.

NEET-II 2016

33. Which of the following is hormone-releasing IUD?
(1) LNG-20
(2) Multiload 375
(3) Lippes Loop
(4) Cu7

NEET-II 2016

34. Which of the following is incorrect regarding vasectomy?
(1) No sperm occurs in seminal fluid
(2) No sperm occurs in epididymis
(3) Vasa deferentia is cut and tied
(4) Irreversible sterility

NEET-I 2016

35. Which of the following approaches does not give the defined action of contraceptive?

(1)	Hormonal contraceptives	-	Prevent/retard entry of sperms, prevent ovulation and fertilisation
(2)	Vasectomy	-	Prevents spermatogenesis
(3)	Barrier methods	-	Prevent fertilisation
(4)	Intra uterine devices	-	Increase phagocytosis of sperms, suppress sperm motility and fertilising capacity of sperms

NEET-II 2016

36. Embryo with more than 16 blastomeres formed due to in vitro fertilisation is transferred into
(1) uterus
(2) fallopian tube
(3) fimbriae
(4) cervix.

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2015 Cancelled

37. Which of the following is not a sexually transmitted disease?
(1) Trichomoniasis
(2) Encephalitis
(3) Syphilis
(4) Acquired Immuno Deficiency Syndrome (AIDS)

2015

38. A childless couple can be assisted to have a child through a technique called GIFT. The full form of this technique is
(1) Gamete Internal Fertilisation and Transfer
(2) Germ cell Internal Fallopian Transfer
(3) Gamete Inseminated Fallopian Transfer
(4) Gamete Intra Fallopian Transfer.

2014

39. Tubectomy is a method of sterilisation in which
(1) small part of the fallopian tube is removed or tied up
(2) ovaries are removed surgically
(3) small part of vas deferens is removed or tied up
(4) uterus is removed surgically.

2014

40. Which of the following is a hormone releasing Intra Uterine Device (IUD)?
(1) Multiload 375
(2) LNG - 20
(3) Cervical cap
(4) Vault

2014

41. Assisted reproductive technology, IVF involves transfer of
(1) ovum into the fallopian tube
(2) zygote into the fallopian tube
(3) zygote into the uterus
(4) embryo with 16 blastomeres into the fallopian tube.

2013

42. Which of the following cannot be detected in a developing fetus by amniocentesis?
(1) Down's syndrome
(2) Jaundice
(3) Klinefelter's syndrome
(4) Sex of the fetus

Karnataka NEET 2013

43. One of the following is not a method of contraception. Which one?
(1) Condoms

1994

66. Which one of the following does correctly match a sexually transmitted disease with its pathogen?
(1) Syphilis-Treponema pallidum
(2) Gonorrhoea-Entamoeba histolytica
(3) Urethritis-Bacillus anthracis
(4) Softsore-Bacillus brevis

1994

67. Which of the following statements is correct with reference to a test tube baby?
(1) Fertilisation of the egg is effected outside the body; the fertilised egg is then placed in the womb of the mother where the gestation is completed.
(2) Fertilisation of the egg is effected in the female genital tract. It is then taken out and grown in a large test tube.
(3) A prematurely born baby is reared in an incubator.
(4) Fertilisation of the egg and growth of the embryo are affected in a large test tube.

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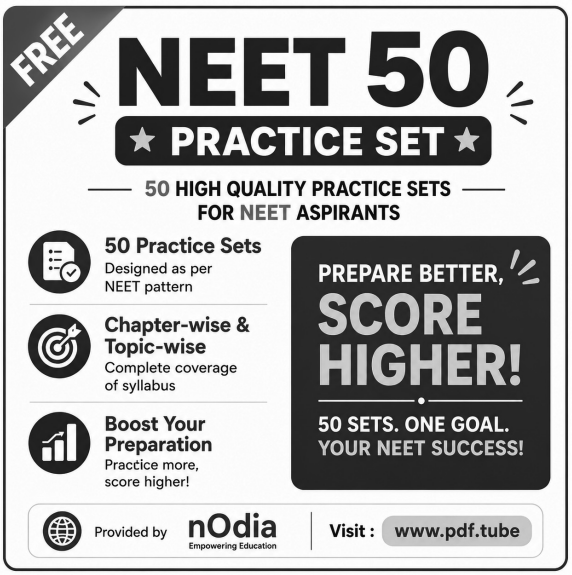

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2010

55. In vitro fertilisation is a technique that involves transfer of which one of the following into the fallopian tube?
(1) Embryo only, upto 8 cell stage
(2) Either zygote or early embryo upto 8 cell stage
(3) Embryo of 32 cell stage
(4) Zygote only

2008

56. Given below are four methods (A-D) and their modes of action (i-iv) in achieving contraception. Select their correct matching from the four options that follow.

	Method		**Mode of Action**
A.	The pill	(i)	Prevents sperms reaching cervix
B.	Condom	(ii)	Prevents implantation
C.	Vasectomy	(iii)	Prevents ovulation
D.	Copper T	(iv)	Semen contains no sperms

(1) A - (iii), B - (iv), C - (i), D - (ii)
(2) A - (ii), B - (iii), C - (i), D - (iv)
(3) A - (iii), B - (i), C - (iv), D - (ii)
(4) A - (iv), B - (i), C - (ii), D - (iii)

2008

57. Consider the statements given below regarding contraception and answer as directed thereafter.
(1) Medical termination of pregnancy (MTP) during first trimester is generally safe.
(2) Generally chances of conception are nil until mother breast-feeds the infant upto two years.
(3) Intrauterine devices like copper-T are effective contraceptives.
(4) Contraception pills may be taken upto one week after coitus to prevent conception.
Which two of the above statements are correct?
(1) 1, 3 (2) 1, 2
(3) 2, 3 (4) 3, 4

2003

58. Test tube baby means a baby born when
(1) it is developed in a test tube
(2) it is developed through tissue culture method
(3) the ovum is fertilised externally and thereafter implanted in the uterus
(4) it develops from a non-fertilised uterus.

2000

59. What is the work of copper-T?
(1) To inhibit ovulation
(2) To inhibit fertilisation
(3) To inhibit implantation of blastocyst
(4) To inhibit gametogenesis

2000

60. What is the work of progesterone which is present in oral contraceptive pills?
(1) To inhibit ovulation
(2) To check oogenesis
(3) To check entry of sperms into cervix and to make them inactive
(4) To check sexual behaviour

NODIA

1999

61. Tablets to prevent male contraception contain
(1) progesterone
(2) LH
(3) FSH
(4) both (2) and (3).

1998

62. The most important component of the oral contraceptive pills is
(1) thyroxine
(2) luteinising hormone
(3) progesterone
(4) growth hormone.

1997

63. Fetal sex can be determined by examining cells from the amniotic fluid by looking for
(1) chiasmata
(2) kinetochore
(3) barr bodies
(4) autosomes.

1997

64. The present population of the world is about
(1) 15 trillion
(2) 6 billion
(3) 500 million
(4) 100 million.

1996

65. The test tube baby means
(1) fertilisation and development both in uterus
(2) fertilisation in vitro and then transplantation in uterus
(3) a baby grown in test tube
(4) fertilised and developed embryo in test tube.

the unborn child led to a rise in female foeticide. Consequently, the government implemented a legal ban on its use for sex determination to promote a balanced sex ratio and child health.

11. (3) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
Different contraceptive devices function through distinct mechanisms to prevent pregnancy. Non-medicated IUDs like Lippes loop increase sperm phagocytosis. Copper-releasing IUDs such as Multiload 375 release ions that suppress sperm motility. Hormone-releasing versions like LNG-20 alter the uterine environment. Vaults act as mechanical rubber barriers that block the cervix, preventing sperm from entering the uterus during coitus.

12. (4) A-III, B-IV, C-II, D-I
Contraception involves various techniques to prevent unwanted pregnancy. Vasectomy is a permanent surgical method for males. Coitus interruptus is a natural method involving the withdrawal of the penis before ejaculation. Cervical caps serve as mechanical barriers for females. Saheli is a unique non-steroidal oral pill taken weekly, which was developed by researchers to provide a convenient hormonal method.

13. (2) Syphilis and Trichomoniasis
The curability of sexually transmitted infections depends largely on the type of pathogen involved. Infections caused by bacteria, such as syphilis and gonorrhoea, or protozoans like Trichomonas vaginalis, can be completely cured with appropriate medical treatment. However, viral infections like HIV, genital herpes, and Hepatitis-B cannot be fully eradicated from the body even with modern medical interventions.

14. (4) Gonorrhoea
Many sexually transmitted diseases can be successfully treated if they are identified early. Gonorrhoea, a bacterial infection, is one such condition that is completely curable with proper antibiotics. In contrast, viral diseases like Hepatitis-B, HIV, and genital herpes remain incurable. Early detection and treatment of bacterial STDs are crucial to prevent long-term health complications and further transmission.

15. (2) Statement I is incorrect but statement II is true.
Intra Cytoplasmic Sperm Injection is a specialized laboratory procedure performed under a microscope, making it an in-vitro fertilisation technique rather than in-vivo. Conversely, artificial insemination is a clinical method used to correct infertility when the male partner cannot inseminate the female or has a low sperm count, by directly introducing sperm into the female reproductive tract.

16. (3) Non-Medicated IUD
Lippes loop is a classic example of a non-medicated intra-uterine device. It is a plastic, double-S shaped device that does not release any chemicals or hormones. Its primary function is to stimulate a local inflammatory response in the uterus, which increases the phagocytosis of sperms by white blood cells, thereby preventing fertilisation and acting as an effective contraceptive.

17. (2) (A)-(iv), (B)-(i), (C)-(ii), (D)-(iii)
Various contraceptive methods utilize different physiological or physical strategies. Diaphragms are mechanical barriers that block the cervix. Oral pills contain hormones that inhibit ovulation and implantation while altering cervical mucus quality. Intra-uterine devices enhance sperm phagocytosis within the uterus. Lactational amenorrhea is a natural period of infertility following childbirth when intense breastfeeding prevents the normal menstrual cycle and ovulation.

18. (3) (i) (iii) (ii) (iv)
Contraceptive techniques range from barriers to surgical procedures. Vaults are barriers that block sperm entry through the cervix. Intra-uterine devices work by increasing the phagocytosis of sperms within the uterus. Vasectomy is a male sterilization technique involving the removal or tying of the vas deferens. Tubectomy is the female equivalent, where a portion of the fallopian tubes is removed.

19. (3) LNG-20
Intra-uterine devices are categorized based on their mechanism of action. LNG-20 is a prominent hormone-releasing IUD that gradually secretes levonorgestrel. This hormone makes the cervix hostile to sperms by thickening the cervical mucus and alters the uterine lining to prevent implantation. Other types include non-medicated versions like Lippes loop and copper-releasing devices like Multiload 375 or CuT.

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ANSWERS

1. (4) Tuberculosis
Gonorrhoea, genital warts and syphilis are all sexually transmitted infections. Tuberculosis is caused by Mycobacterium tuberculosis and spreads mainly through air-borne droplets affecting the lungs, not by sexual contact.

2. (1) Intra cytoplasmic sperm injection (ICSI)
ICSI is a specialised in vitro technique in which a single sperm is directly injected into the cytoplasm of the ovum to achieve fertilisation. It is used to overcome male infertility.

3. (1) A-III, B-IV, C-I, D-II
Progestasert is a hormone-releasing IUD. Multiload 375 is a copper-releasing IUD. The diaphragm is a barrier made of rubber used by females. Saheli is a non-steroidal oral contraceptive pill. This gives the correct matching A-III, B-IV, C-I, D-II.

4. (4) It is the transfer of an ovum collected from a donor into the fallopian tube of another female who cannot produce ovum but can provide suitable environment for fertilization and development.
GIFT (Gamete Intra Fallopian Transfer) involves transferring an ovum from a donor into the fallopian tube of a female who cannot produce her own ovum but can support fertilisation and development. The other options describe IUT or ZIFT procedures, not GIFT, making option (4) the correct statement.

5. (4) A-II, B-IV, C-I, D-III
IUDs and barrier methods are essential contraceptive tools. Multiload 375 acts as a copper-releasing device that suppresses sperm motility. Lippes loop is a non-medicated variety that increases sperm phagocytosis. Vaults serve as physical rubber barriers covering the cervix. LNG-20 releases hormones to make the uterus unsuitable for implantation and the cervix hostile to sperms, effectively preventing pregnancy through multiple biochemical mechanisms.

6. (4) A-III, B-I, C-IV, D-II
Contraceptive methods are categorized by their specific functional mechanisms. Non-medicated devices like Lippes loop increase sperm phagocytosis within the uterus. Copper-releasing types such as Multiload 375 release ions to suppress sperm motility. Hormone-releasing IUDs like LNG-20 alter the cervical mucus. Implants utilize progestogens for long-term pregnancy prevention by inhibiting ovulation and changing the uterine lining.

7. (4) Vaults
Natural or traditional contraceptive methods rely on avoiding the meeting of ovum and sperm without using artificial devices. These include periodic abstinence, coitus interruptus, and lactational amenorrhea. In contrast, vaults are physical barrier methods made of rubber that are inserted into the female reproductive tract to cover the cervix, thereby mechanically blocking the entry of sperm.

8. (2) B and D only
Sexually transmitted diseases vary in their treatability depending on the causative agent. While bacterial infections like syphilis and parasitic ones like trichomoniasis are curable with antibiotics, certain viral infections remain persistent. Genital herpes and Hepatitis-B, along with HIV, are currently considered not completely curable. Treatment for these conditions focuses on managing symptoms and reducing the viral load.

9. (3) (A), (B) and (D) only
Reproductive health encompasses total well-being in physical, emotional, behavioral, and social aspects of reproduction. Legal measures in India ban amniocentesis for sex determination to prevent female foeticide. Amniocentesis remains a vital diagnostic tool for identifying genetic disorders and chromosomal abnormalities in the fetus. Oral contraceptives like Saheli were developed by the Central Drug Research Institute researchers.

10. (2) (A) is false but (R) is true.
Amniocentesis is a diagnostic procedure meant for detecting genetic abnormalities or chromosomal disorders in a developing fetus. However, its misuse for determining the sex of

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(2) Pills of a combination of oxytocin and vasopressin
(3) Lippes Loop
(4) Tubectomy

2013

44. One of the legal methods of birth control is
(1) by having coitus at the time of day break
(2) by a premature ejaculation during coitus
(3) abortion by taking an appropriate medicine
(4) by abstaining from coitus from day 10 to 17 of the menstrual cycle.

Karnataka NEET 2013

45. Which one of the following statements is correct regarding sexually transmitted diseases (STDs)?
(1) A person may contract syphilis by sharing milk with one already suffering from the disease.
(2) Haemophilia is one of the STDs.
(3) Genital herpes and sickle-cell anaemia are both STDs.
(4) The chances of a 5-years boy contracting a STD are very little.

2013

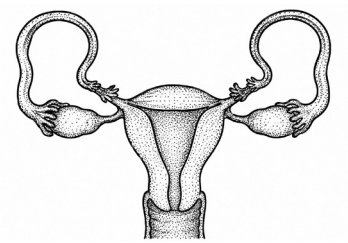
46. Artificial Insemination means
(1) artificial introduction of sperms of a healthy donor into the vagina
(2) introduction of sperms of a healthy donor directly into the ovary
(3) transfer of sperms of a healthy donor to a test tube containing ova
(4) transfer of sperms of husband to a test tube containing ova.

Karnataka NEET 2013

47. The stage transferred into the uterus after induced fertilisation of ovum in the laboratory is
(1) embryo at 4 blastomeres stage
(2) embryo at 2 blastomeres stage
(3) morula
(4) zygote.

2012

48. What is the figure given below showing in particular?



(1) Ovarian cancer
(2) Uterine cancer
(3) Tubectomy
(4) Vasectomy

2012

49. The test-tube baby programme employs which one of the following techniques?
(1) Intra Cytoplasmic Sperm Injection (ICSI)
(2) Intra Uterine Insemination (IUI)
(3) Gamete Intra Fallopian Transfer (GIFT)
(4) Zygote Intra Fallopian Transfer (ZIFT)

2011

50. Which one of the following is the most widely accepted method of contraception in India at present?
(1) Cervical caps
(2) Tubectomy
(3) Diaphragms
(4) IUDs (Intra uterine devices)

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2011

51. Medical Termination of Pregnancy (MTP) is considered safe up to how many weeks of pregnancy?
(1) Eight weeks (2) Twelve weeks
(3) Eighteen weeks (4) Six weeks

Mains 2011

52. The technique called Gamete Intra Fallopian Transfer (GIFT) is recommended for those females
(1) who cannot produce an ovum
(2) who cannot retain the fetus inside uterus
(3) whose cervical canal is too narrow to allow passage for the sperms
(4) who cannot provide suitable environment for fertilisation.

2010

53. The permissible use of the technique amniocentesis is for
(1) detecting sex of the unborn fetus
(2) artificial insemination
(3) transfer of embryo into the uterus of a surrogate mother
(4) detecting any genetic abnormality.

2010

54. Cu ions released from copper-releasing intra uterine devices (IUDs)
(1) make uterus unsuitable for implantation
(2) increase phagocytosis of sperms
(3) suppress sperm motility
(4) prevent ovulation.

20. (4) (B) and (C) only
Venereal diseases, or sexually transmitted infections, can be transmitted through several routes besides sexual contact. Common modes of transmission include the transfusion of contaminated blood and sharing infected needles among drug users. Additionally, an infected mother can pass certain infections to her developing fetus during pregnancy or childbirth. Understanding these pathways is essential for preventing the spread.

21. (1) Gonorrhoea, Syphilis, Genital herpes
Sexually transmitted diseases are infections primarily spread through sexual contact. This group of diseases includes bacterial infections like gonorrhoea and syphilis, as well as viral infections like genital herpes and HIV. While malaria and filaria are caused by parasites transmitted via insect vectors, cancer is a non-infectious condition involving abnormal cell growth. Identifying STDs correctly is vital for treatment.

22. (3) B, D, F only
In-vitro fertilisation is a complex assisted reproductive technology with several significant drawbacks. The process requires highly specialized, expensive instruments and reagents, making it unavailable for many. There is also a risk that early embryos may not survive the transfer process. Furthermore, the focus on such advanced technologies can sometimes lead to decreased interest in the legal adoption of orphans.

23. (1) ZIFT and IUT
Assisted reproductive technologies help individuals overcome various infertility issues. Zygote Intra Fallopian Transfer involves placing an early embryo into the fallopian tube. Intra Uterine Transfer is used for embryos with more than eight blastomeres, which are placed directly into the uterus. Both techniques are critical components of the embryo transfer process designed to assist females who cannot naturally conceive.

24. (2) Lactational amenorrhea, Pills, Emergency contraceptives
Hormones play a central role in several contraceptive methods. Oral pills and emergency contraceptives use synthetic hormones to prevent ovulation and thicken cervical mucus. Lactational amenorrhea is a natural hormonal state where high prolactin levels during intense breastfeeding suppress the release of gonadotropins, thereby preventing ovulation. Barrier methods and copper-releasing IUDs do not rely on hormones for their effect.

25. (4) Progestasert, LNG-20
Intra-uterine devices are classified into different types based on how they function. Hormone-releasing IUDs, such as Progestasert and LNG-20, work by releasing progestogens. These hormones make the uterus unsuitable for implantation and increase the thickness of cervical mucus, preventing sperm entry. This distinguishes them from copper-releasing devices like Multiload 375 and non-medicated versions like the Lippes loop.

26. (3) IUDs increase phagocytosis of sperms in the uterus.
Intra-uterine devices are highly effective contraceptives inserted into the uterus by medical professionals. One of their primary mechanisms of action is increasing the phagocytosis of sperms within the uterine cavity. This local immune response, combined with the release of ions or hormones in specific types, effectively reduces sperm motility and fertilizing capacity, thereby preventing successful conception from occurring.

27. (4) Genital herpes
While many sexually transmitted diseases can be treated with modern medicine, some viral infections remain a major challenge. Diseases like chlamydiasis, gonorrhoea, and genital warts are often manageable or curable. However, genital herpes, caused by the herpes simplex virus, along with HIV and Hepatitis-B, is not completely curable. Management for these conditions typically focuses on suppressing the virus.

28. (1) blocks estrogen receptors in the uterus, preventing eggs from getting implanted
Saheli is a unique oral contraceptive pill developed by the Central Drug Research Institute in India. Unlike traditional pills, it is non-steroidal and contains centchroman. Its mechanism involves blocking estrogen receptors in the uterus, which prevents the fertilized egg from getting implanted. Being a "once-a-week" pill with very few side effects, it is considered a highly effective contraceptive.

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29. (4) they suppress sperm motility and fertilising capacity of sperms.
Copper-releasing intra-uterine devices function primarily by releasing copper ions into the uterine environment. These ions are toxic to sperms, significantly suppressing their motility and reducing their ability to fertilize an egg. By impairing the movement and survival of sperms, these devices provide a highly effective method of birth control that does not interfere with the female's natural hormonal cycle.

30. (4) (ii) (iii) (iv) (i)
Sexually transmitted diseases are caused by various specific pathogens. Gonorrhoea is a bacterial infection caused by Neisseria gonorrhoeae, while syphilis is caused by the bacterium Treponema pallidum. Genital warts result from infection with the Human Papilloma Virus. AIDS is caused by the Human Immunodeficiency Virus. Correct identification of these causative agents is essential for choosing the appropriate medical treatment.

31. (2) Artificial Insemination
Artificial Insemination is an assisted reproductive technique used when the male partner has a very low sperm count or is unable to inseminate the female naturally. In this procedure, semen collected from the husband or a healthy donor is artificially introduced into the female's vagina or uterus. This increases the chances of sperm reaching the egg for fertilisation.

32. (2) It can be used for detection of cleft palate.
Amniocentesis is a prenatal diagnostic technique used to detect chromosomal abnormalities, such as Down's syndrome, and metabolic disorders by analyzing fetal cells in the amniotic fluid. It is also used to determine the sex of the fetus. However, it cannot be used to detect structural abnormalities like a cleft palate, which are typically identified through ultrasound imaging instead.

33. (1) LNG-20
Hormone-releasing intra-uterine devices are effective long-term contraceptives. LNG-20 is a prime example that releases the hormone levonorgestrel directly into the uterus. This action makes the cervical mucus thick, preventing sperm from entering, and alters the uterine lining to prevent implantation. Other devices like Multiload 375 and Cu7 release copper, while the Lippes loop is a non-medicated plastic device.

34. (2) No sperm occurs in epididymis
Vasectomy is a surgical sterilization method for males where a small part of the vasa deferentia is removed or tied. This prevents the transport of sperm from the testes to the urethra, meaning no sperm is present in the seminal fluid. Importantly, spermatogenesis continues in the testes, and the produced sperms are eventually reabsorbed in the epididymis.

35. (2) Vasectomy - Prevents spermatogenesis
Contraceptive methods have specific intended actions. Hormonal contraceptives prevent ovulation and fertilisation, while barrier methods physically block sperm from reaching the egg. Intra-uterine devices increase sperm phagocytosis and suppress motility. However, vasectomy is a sterilization technique that blocks the transport of sperm through the vas deferens; it does not stop the process of spermatogenesis from occurring within the testes.

36. (1) uterus
Assisted reproductive technology involves the transfer of embryos into the female reproductive tract. If an embryo is formed through in vitro fertilisation and reaches a stage with more than eight blastomeres, such as the 16-cell stage, it is typically transferred directly into the uterus. This procedure is known as Intra Uterine Transfer, whereas earlier stages are transferred into the fallopian tube.

37. (2) Encephalitis
Sexually transmitted diseases are infections spread through sexual contact with an infected partner. Common examples include trichomoniasis, syphilis, and AIDS. Encephalitis, however, is a condition characterized by inflammation of the brain, often caused by viral infections like West Nile or herpes simplex, but it is not classified as a disease primarily transmitted through sexual intercourse or contact.

38. (4) Gamete Intra Fallopian Transfer.
Gamete Intra Fallopian Transfer is an assisted reproductive technique designed for women who cannot produce their own eggs but possess a healthy uterus and fallopian tubes. In this procedure, an ovum collected from a donor is transferred into the fallopian tube of another

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female who cannot produce one. This allows fertilisation to occur naturally inside the woman's body rather than in a laboratory.

39. (1) small part of the fallopian tube is removed or tied up
Tubectomy is a permanent surgical method of sterilization for females. During this procedure, a small part of each fallopian tube is either removed or tied up through a small incision in the abdomen or through the vagina. This effectively blocks the passage of the egg towards the uterus, thereby preventing fertilisation and providing a highly reliable form of contraception.

40. (2) LNG - 20
Intra-uterine devices are categorized into non-medicated, copper-releasing, and hormone-releasing types. LNG-20 belongs to the hormone-releasing category, as it secretes levonorgestrel to prevent pregnancy. In contrast, Multiload 375 is a copper-releasing device, while cervical caps and vaults are physical barrier methods. Hormone-releasing IUDs are particularly effective because they alter the cervical mucus and make the uterus unsuitable for implantation.

41. (2) zygote into the fallopian tube
In-vitro fertilisation followed by embryo transfer is a major component of assisted reproductive technology. One common technique is Zygote Intra Fallopian Transfer, where the zygote or an early embryo with up to eight blastomeres is moved into the fallopian tube. If the embryo has more than eight blastomeres, it is instead transferred directly into the uterus for further development.

42. (2) Jaundice
Amniocentesis is a medical procedure used to analyze the amniotic fluid surrounding a developing fetus. It is highly effective for detecting chromosomal abnormalities like Down's syndrome and Klinefelter's syndrome, as well as determining fetal sex. However, it cannot detect non-genetic conditions such as jaundice, which is a symptom of liver dysfunction or blood cell breakdown rather than a chromosomal disorder.

43. (2) Pills of a combination of oxytocin and vasopressin
Contraception involves various methods like physical barriers, hormonal treatments, and surgical procedures. Condoms and Lippes loop are well-known barriers and intra-uterine devices, respectively. Tubectomy is a permanent surgical sterilization. However, pills containing a combination of oxytocin and vasopressin are not used for contraception; instead, standard contraceptive pills contain synthetic versions of the hormones estrogen and progesterone to prevent ovulation.

44. (4) by abstaining from coitus from day 10 to 17 of the menstrual cycle.
Natural methods of birth control rely on physiological cycles. Periodic abstinence is one such legal method where couples avoid coitus during the fertile window, typically from day 10 to 17 of the menstrual cycle, when ovulation is most likely. This reduces the chance of sperm meeting the egg. While medical procedures exist, they are distinct from these behavioral natural methods.

45. (4) The chances of a 5-years boy contracting a STD are very little.
Sexually transmitted diseases are primarily spread through sexual contact. Young children, such as a five-year-old boy, have an extremely low risk of contracting these infections because they are not sexually active. While some STIs can be transmitted through blood or from mother to child, conditions like haemophilia and sickle-cell anaemia are genetic disorders, not infectious diseases spread through contact.

46. (1) artificial introduction of sperms of a healthy donor into the vagina
Artificial Insemination is a specialized technique used in assisted reproduction to help couples conceive. It involves the deliberate and artificial introduction of sperm, obtained from either the husband or a healthy donor, into the female's reproductive tract, usually the vagina or uterus. This method is particularly beneficial when the male partner has a low sperm count or difficulty with natural insemination.

47. (3) morula
In the process of in-vitro fertilisation, the embryo is grown in a laboratory before being transferred. When the embryo reaches a stage with more than 8 blastomeres, such as a 16-cell morula, it is often transferred directly into the uterus. This differs from Zygote Intra Fallopian Transfer, where the zygote or early embryos with fewer blastomeres are placed in the tubes.

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48. (3) Tubectomy
Tubectomy is a permanent surgical procedure for female sterilization. The process involves cutting or tying the fallopian tubes to prevent the egg from traveling from the ovary to the uterus. This blockage ensures that sperm cannot reach the egg, thus preventing fertilisation. It is a highly effective contraceptive method often chosen by women who do not wish to have children.

49. (4) Zygote Intra Fallopian Transfer (ZIFT)
The test-tube baby programme utilizes various assisted reproductive technologies. Zygote Intra Fallopian Transfer is a key technique where fertilisation occurs outside the body, and the resulting zygote or early embryo is then transferred into the fallopian tube. This allows for subsequent development to occur naturally within the female reproductive system, providing an option for couples facing certain types of infertility.

50. (4) IUDs (Intra uterine devices)
Intra-uterine devices are currently the most widely accepted and popular method of contraception in India. These devices are inserted into the uterus by doctors or trained nurses. They offer long-term protection and are highly effective. Common types include non-medicated ones, copper-releasing versions like CuT, and hormone-releasing variants, making them a versatile choice for many women seeking reliable birth control.

51. (2) Twelve weeks
Medical Termination of Pregnancy refers to the intentional or voluntary termination of pregnancy before full term. It is widely considered safe and carries fewer risks when performed during the first trimester, which extends up to twelve weeks of gestation. Beyond this period, the procedure becomes significantly more complex and poses greater health risks to the mother, requiring more stringent medical oversight.

52. (1) who cannot produce an ovum
Gamete Intra Fallopian Transfer is a specialized procedure recommended for females who are unable to produce an ovum but can still provide a suitable environment for fertilisation and fetal development. In this technique, an egg from a donor is placed into the female's fallopian tube along with sperm, allowing the natural process of fertilisation to take place internally.

53. (4) detecting any genetic abnormality.
Amniocentesis is a prenatal diagnostic procedure that involves sampling the amniotic fluid. Its primary and legally permissible use is the detection of genetic abnormalities, such as chromosomal disorders or metabolic imbalances in the fetus. While it can also determine the sex of the unborn child, using the technique for this purpose is prohibited in many regions to prevent sex-selective abortions.

54. (3) suppress sperm motility
Copper-releasing intra-uterine devices are effective because they continuously release copper ions into the uterine cavity. These ions significantly suppress the motility of sperms and reduce their ability to fertilize the ovum. By interfering with the physiological processes required for sperm to reach and penetrate the egg, these devices provide a reliable non-hormonal method of preventing pregnancy for several years.

55. (2) Either zygote or early embryo upto 8 cell stage
In-vitro fertilisation involves the fertilisation of an egg by sperm outside the body in a laboratory setting. Following this, the resulting zygote or an early embryo with up to eight blastomeres is transferred into the fallopian tube. This specific procedure is known as ZIFT. If the embryo develops further, it is typically transferred directly into the uterus instead.

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56. (3) A - (iii), B - (i), C - (iv), D - (ii)
Contraceptive methods work through different biological or physical pathways. Oral pills primarily function by preventing ovulation. Condoms act as barriers that prevent sperm from reaching the cervix. Vasectomy is a surgical method that ensures semen contains no sperm. Copper-releasing devices like the Copper T work by suppressing sperm motility and fertilising capacity through ion release, while also being associated with preventing implantation.

57. (1) 1, 3
Medical termination of pregnancy is considered a safe option when performed during the first trimester. Furthermore, intra-uterine devices like the copper-T are recognized as highly effective long-term contraceptives. In contrast, the period of lactational amenorrhea is generally effective for only up to six months after childbirth, and

emergency contraceptive pills must be taken much sooner than one week after coitus.

58. (3) the ovum is fertilised externally and thereafter implanted in the uterus
The term "test-tube baby" refers to a child conceived through in-vitro fertilisation. In this process, the egg is fertilised by sperm in a laboratory environment, outside the mother's body. Once the embryo has reached a certain stage of development, it is then implanted into the woman's uterus, where it continues to grow and develop until birth occurs naturally.

59. (2) To inhibit fertilisation
Copper-T is a widely used intra-uterine device that primarily functions to prevent pregnancy by inhibiting fertilisation. It releases copper ions into the uterus, which are toxic to sperms. These ions suppress sperm motility and their ability to reach the egg. Additionally, the presence of the device can alter the uterine environment, making it less receptive to the implantation process.

60. (1) To inhibit ovulation
Progesterone is a key hormone found in many oral contraceptive pills. Its primary role in birth control is to inhibit ovulation by suppressing the release of follicle-stimulating hormone and luteinising hormone from the pituitary gland. Additionally, it thickens the cervical mucus to block sperm entry and alters the uterine lining, which together provide multiple layers of protection against pregnancy.

61. (1) progesterone
Research into male contraception has explored several hormonal approaches. Some experimental tablets for males contain progesterone or similar progestogens. These hormones work by inhibiting the secretion of gonadotropins, specifically follicle-stimulating hormone and luteinising hormone, which are necessary for the process of spermatogenesis. By suppressing these hormones, the production of sperm is significantly reduced, effectively acting as a form of contraception.

62. (3) progesterone
Progesterone is the most critical component found in oral contraceptive pills. It functions by inhibiting the ovulation process and altering the consistency of cervical mucus, making it difficult for sperm to enter the uterus. In many formulations, it is combined with estrogen to enhance its effectiveness and regulate the menstrual cycle, providing a highly reliable method of birth control.

63. (3) barr bodies
Fetal sex can be determined by analyzing cells obtained from the amniotic fluid. In female cells, one of the X chromosomes remains condensed and visible as a dark-staining structure called a Barr body. By examining these cells under a microscope, the presence of a Barr body indicates a female fetus, while its absence suggests the fetus is male.

64. (2) 6 billion
During the late 20th century, specifically by the year 2000, the global human population reached a significant milestone of approximately 6 billion people. This rapid growth was driven by improvements in healthcare, nutrition, and sanitation, which decreased mortality rates worldwide. Monitoring population trends is essential for understanding global resource needs and the impact of human activity on the environment and sustainability.

65. (2) fertilisation in vitro and then transplantation in uterus
A test-tube baby is produced using assisted reproductive technology where fertilisation occurs in a controlled laboratory environment. This in-vitro fertilisation involves combining an egg and sperm outside the body. After the zygote or early embryo reaches a specific stage of development, it is then transplanted into the uterus of the female for gestation, leading to a normal pregnancy and birth.

66. (1) Syphilis-Treponema pallidum
Sexually transmitted diseases are each associated with specific infectious agents. Syphilis is accurately matched with the bacterium Treponema pallidum. Other matches are incorrect; for example, gonorrhoea is caused by Neisseria gonorrhoeae rather than Entamoeba histolytica, which causes amoebiasis. Understanding the correct pathogen is vital for diagnosis and the administration of appropriate antibiotic or antiviral treatments for these various infections.

67. (1) Fertilisation of the egg is effected outside the body; the fertilised egg is then placed in

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Choose the correct answer from the options given below.
(1) A-III, B-IV, C-II, D-I
(2) A-II, B-I, C-IV, D-III
(3) A-II, B-III, C-I, D-IV
(4) A-IV, B-I, C-III, D-II

RE-EXAM 2024

22. Aneuploidy is a chromosomal disorder where chromosome number is not the exact copy of its haploid set of chromosomes, due to
A. Substitution
B. Addition
C. Deletion
D. Translocation
E. Inversion
Choose the most appropriate answer from the options given below.
(1) C and D only
(2) D and E only
(3) A and B only
(4) B and C only

RE-EXAM 2024

23. Given below are two statements.
Statement I : Failure of segregation of chromatids during cell cycle resulting in the gain or loss of whole set of chromosome in an organism is known as aneuploidy.
Statement II : Failure of cytokinesis after anaphase stage of cell division results in the gain or loss of a chromosome is called polyploidy.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

2024

24. Match List I with List II.

	List-I		List-II
A.	Down's syndrome	I.	11^{th} chromosome
B.	α-Thalassemia	II.	'X' chromosome
C.	β-Thalassemia	III.	21^{st} chromosome
D.	Klinefelter's syndrome	IV.	16^{th} chromosome

Choose the correct answer from the options given below.
(1) A-I, B-II, C-III, D-IV
(2) A-II, B-III, C-IV, D-I
(3) A-III, B-IV, C-I, D-II
(4) A-IV, B-I, C-II, D-III

Manipur NEET 2023

25. A heterozygous pea plant with violet flowers was crossed with homozygous pea plant with white flower. Violet is dominant over white. Which one of the following represents the expected combinations among 40 progenies formed?
(1) 30 produced violet and 10 produced white flowers
(2) 20 produced violet and 20 produced white flowers
(3) All 40 produced violet flowers
(4) All 40 produced white flowers

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Manipur NEET 2023

26. A certain plant homozygous for yellow seeds and red flowers was crossed with a plant homozygous for green seeds and white flowers. The F_1 plants had yellow seeds and pink flowers. The F_1 plants were selfed to get F_2 progeny. Assuming independent assortment of the two characters, how many phenotypic categories are expected for these characters in the F_2 generation?
(1) 9
(2) 16
(3) 4
(4) 6

Manipur NEET 2023

27. Match List-I with List-II.

	List I (Type of cross)		List II (Phenotypic ratio)
A.	Monohybrid cross	I.	1 : 1
B.	Dihybrid cross	II.	1 : 2 : 1
C.	Incomplete dominance	III.	3 : 1
D.	Test cross	IV.	9 : 3 : 3 : 1

Choose the correct answer from the options given below.
(1) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)
(2) (A)-(III), (B)-(IV), (C)-(III), (D)-(I)
(3) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
(4) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

2023

28. Frequency of recombination between gene pairs on same chromosome as a measure of the distance between genes to map their position on chromosome, was used for the first time by

CHAPTER 23

Principles of Inheritance and Variation

NODIA

2026 (RE-NEET)

1. Given below are two statements

Statement I: Down's syndrome is caused by the absence of one of the X-chromosomes.

Statement II: Turner's syndrome is caused by the presence of an additional copy of the chromosome.

(1) Statement I is correct but Statement II is incorrect
(2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Both Statement I and Statement II are incorrect

2026 (RE-NEET)

2. For a person with blood group O, which is not a possible combination of parents' blood group genotypes?

(1) Father: IBi and Mother: IBi
(2) Father: IAIB and Mother: IAi
(3) Father: IAi and Mother: IBi
(4) Father: IAi and Mother: IAi

2026 (RE-NEET)

3. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: In an experiment, Mendel observed that the F1 progeny plants are all tall and none are dwarf.

Reason R: Stem height is a contrasting trait, with tall being dominant and dwarf being recessive.

In the light of the above statements,choose the most appropriate answer from the options given below

(1) A is correct but R is not correct
(2) A is not correct but R is correct
(3) Both A and R are correct and R is the correct explanation of A
(4) Both A and R are correct but R is not the correct explanation of A

2026 (CANCELLED)

4. Match List I with List II:

List I:

A. Incomplete dominance
B. Co-dominance
C. Pleiotropy
D. Polygenic inheritance

List II:

I. Human skin colour
II. Inheritance of flower colour in Antirrhinum sp.
III. Phenylketonuria disease in humans
IV. ABO blood groups

(1) A-II, B-IV, C-III, D-I
(2) A-I, B-III, C-II, D-IV
(3) A-I, B-IV, C-III, D-II
(4) A-II, B-I, C-III, D-IV

2026 (CANCELLED)

5. Which of the following statements are true with reference to the sex-determination in honeybees?

A. An offspring formed from the union of a sperm and an egg, develops as a female (queen or worker).
B. An unfertilized egg develops as a male by parthenogenesis.
C. A male has half the number of chromosomes than that of a female.
D. Males produce sperms by meiosis.
E. Honeybees have a haplodiploid sex-determination system.

Choose the correct answer from the options given below:

(1) A, B, C and E only
(2) B, C, D and E only
(3) A, B, C and D only
(4) A, B, D and E only

2026 (CANCELLED)

6. Which one of the following disorders is caused by the substitution of Glutamic acid (Glu) by Valine (Val) at the sixth position of the beta globin chain of the haemoglobin molecule?

(1) Thalassemia
(2) Sickle-cell anaemia
(3) Phenylketonuria
(4) Haemophilia

2026 (CANCELLED)

7. What is the probability of having children with 'O' blood group, where both mother and father are heterozygous for 'A' and 'B' blood group, respectively?

In the light of the above statements, choose the correct answer from the options given below :
(1) Both (A) and (R) are correct and (R) is the correct explanation of (A)
(2) Both (A) and (R) are correct but (R) is not the correct explanation of (A)
(3) (A) is correct but (R) is not correct.
(4) (A) is not correct but (R) is correct.

2022

37. The recombination frequency between the genes a & c is 5%, b & c is 15%, b & d is 9%, a & b is 20%, c & d is 24% and a & d is 29%.
What will be the sequence of these genes on a linear chromosome ?
(1) a, d, b, c
(2) d, b, a, c
(3) a, b, c, d
(4) a, c, b, d

2022

38. XO type of sex determintaion can be found in :
(1) Drosophila
(2) Birds
(3) Grasshoppers
(4) Monkeys

2022

39. Which of the following occurs due to the presence of autosome linked dominant trait ?
(1) Sickle cell anaemia
(2) Myotonic dystrophy
(3) Haemophilia
(4) Thalessemia

2022

40. If a colourblind female marries a man whose mother was also colourblind, what are the chances of her progeny having colour blindness ?
(1) 25%
(2) 50%
(3) 75%
(4) 100%

2021

41. The production of gametes by the parents, formation of zygotes, the F_1 and F_2 plants, can be understood from a diagram called
(1) net square
(2) bullet square
(3) punch square
(4) Punnett square

2021

42. In a cross between a male and female, both heterozygous for sickle cell anaemia gene, what percentage of the progeny will be diseased?
(1) 100%
(2) 50%
(3) 75%
(4) 25%

2020

43. How many true breeding pea plant varieties did Mendel select as pairs, which were similar except in one character with contrasting traits?
(1) 4
(2) 2
(3) 14
(4) 8

2020

44. Identify the wrong statement with reference to the gene 'I' that controls ABO blood groups.
(1) The gene (I) has three alleles.
(2) A person will have only two of the three alleles.
(3) When IA and IB are present together, they express same type of sugar.
(4) Allele i does not produce any sugar.

2020

45. Experimental verification of the chromosomal theory of inheritance was done by
(1) Mendel
(2) Sutton
(3) Boveri
(4) Morgan.

2020

46. Select the correct match.

(1) Haemophilia	-	Y linked
(2) Phenylketonuria	-	Autosomal dominant trait
(3) Sickle cell anaemia	-	Autosomal recessive trait, chromosome-11
(4) Thalassemia	-	X linked

2019

47. In Antirrhinum (Snapdragon), a red flower was crossed with a white flower and in F_1 generation all pink flowers were obtained. When pink flowers were selfed, the F_2 generation showed white, red and pink flowers. Choose the incorrect statements from the following.
(1) Law of segregation does not apply in this experiment.

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C.	I^Bi	I^AI^A	I^AI^B
D.	I^AIA	I^BI^B	I^Ai
E.	I^Ai	I^Bi	I^Ai

Choose the correct answer from the options given below.
(1) C and D only (2) D and A
(3) A and B (4) B and E

2024

15. As per ABO blood grouping system, the blood group of father is B^+, mother is A^+ and child is O^+. Their respective genotype can be

	Father	**Mother**	**Child**
A.	I^Bi	I^Ai	ii
B.	I^BI^B	I^AI^A	ii
C.	I^AI^B	I^AI^A	I^Bi
D.	I^Ai	I^Bi	I^Ai
E.	iI^B	iI^A	I^AI^B

Choose the most appropriate answer from the options given below.
(1) A only
(2) B only
(3) C and B only
(4) D and E only

2024

16. A pink flowered snapdragon plant was crossed with a red flowered snapdragon plant. What type of phenotype/s is/are expected in the progeny?
(1) Only red flowered plants
(2) Red flowered as well as pink flowered plants
(3) Only pink flowered plants
(4) Red, pink as well as white flowered plants

2024

17. In a plant, black seed color (BB/Bb) is dominant over white seed color (bb). In order to find out the genotype of the black seed plant, with which of the following genotype will you cross it?
(1) BB (2) bb
(3) Bb (4) BB/Bb

2024

18. Match List I with List II.

	List-I		List-II
A.	Two or more alternative forms of a gene	I.	Back cross
B.	Cross of F1 progeny with homozygous recessive parent	II.	Ploidy
C.	Cross of F1 progeny with any of the parents	III.	Allele
D.	Number of chromosome sets in plant	IV.	Test cross

Choose the correct answer from the options given below.
(1) A-I, B-II, C-III, D-IV
(2) A-II, B-I, C-III, D-IV
(3) A-III, B-IV, C-I, D-II
(4) A-IV, B-III, C-II, D-I

RE-EXAM 2024

19. When a tall pea plant with round seeds was selfed, it produced the progeny of
A. tall plants with round seeds and
B. tall plants with wrinkled seeds.
Identify the genotype of the parent plant.
(1) TtRr (2) TtRR
(3) TTRR (4) TTRr

RE-EXAM 2024

20. Given below are two statements.
Statement I : When many alleles of a single gene govern a character, it is called polygenic inheritance.
Statement II : In polygenic inheritance, the effect of each allele is additive.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

RE-EXAM 2024

21. Match List-I with List-II.

	List-I (Type of Inheritance)		List-II (Example)
A.	Incomplete dominance human	I.	Blood groups in
B.	Co-dominance	II.	Flower colour in Antirrhinum
C.	Pleiotropy	III.	Skin colour in human
D.	Polygenic inheritance	IV.	Phenylketonuria

NODIA

(1) 25%
(2) 0%
(3) 75%
(4) 50%

2026 (CANCELLED)

8. In a population of a grasshopper species, the chromosome number of some members is 23 and some other members possess 24 chromosomes. The 23 and 24 chromosome-bearing members in this species are _ _ _ _ _.
(1) females and males, respectively
(2) all males
(3) males and females, respectively
(4) all females

2026 (CANCELLED)

9. In which animal do haploid cells divide mitotically to produce gametes?
(1) Male honeybees
(2) Male earthworms
(3) Male frogs
(4) Male grasshoppers

2025

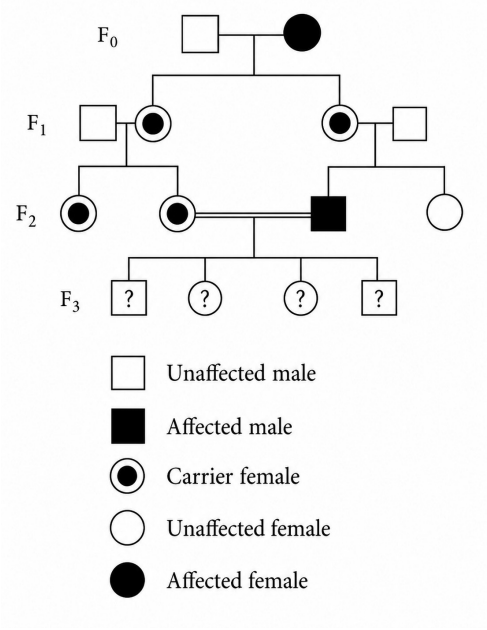
10. Genes R and Y follow independent assortment. If RRYY produce round yellow seeds and rryy produce wrinkled green seeds, what will be the phenotypic ratio of the F_2 generation?
(1) Phenotypic ratio - 9 : 3 : 3 : 1
(2) Phenotypic ratio - 9 : 7
(3) Phenotypic ratio - 1 : 2 : 1
(4) Phenotypic ratio - 3 : 1

2025

11. What is the pattern of inheritance for polygenic trait?
(1) Autosomal dominant pattern
(2) X-linked recessive inheritance pattern
(3) Mendelian inheritance pattern
(4) Non-mendelian inheritance pattern

2025

12. With the help of given pedigree, find out the probability for the birth of a child having no disease and being a carrier (has the disease mutation in one allele of the gene) in F3 generation.



(1) 1/8 (2) Zero
(3) 1/4 (4) 1/2

2024

13. Which one of the following can be explained on the basis of Mendel's Law of Dominance?
A. Out of one pair of factors one is dominant and the other is recessive.
B. Alleles do not show any expression and both the characters appear as such in F_2 generation.
C. Factors occur in pairs in normal diploid plants.
D. The discrete unit controlling a particular character is called factor.
E. The expression of only one of the parental characters is found in a monhybrid cross.
Choose the correct answer from the options given below.
(1) A, B and C only
(2) A, C, D and E only
(3) B, C and D only
(4) A, B, C, D and E

RE-EXAM 2024

14. The mother has A^+ blood group, the father has B^+ and the child is A^+. What can be the possible genotypes of all three, respectively?

	Mother (A^+)	Father (B^+)	Child (A^+)
A.	I^AI^A	I^Bi	I^Bi
B.	I^AI^A	I^Bi	I^Ai

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(1) Alfred Sturtevant
(2) Henking
(3) Thomas Hunt Morgan
(4) Sutton and Boveri.

2023

29. The phenomenon of pleiotropism refers to
(1) a single gene affecting multiple phenotypic expression
(2) more than two genes affecting a single character
(3) presence of several alleles of a single gene controlling a single crossover
(4) presence of two alleles, each of the two genes controlling a single trait.

Manipur NEET 2023

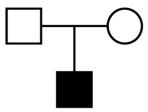
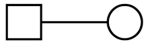
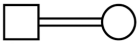
30. Select the correct statement(s) with respect to mechanism of sex determination in grasshopper.
(A) It is an example of female heterogamety.
(B) Male produces two different types of gametes either with or without X chromosome.
(C) Total number of chromosomes (autosomes and sex chromosomes) is same in both males and females.
(D) All eggs bear an additional X chromosome besides the autosomes.
Choose the correct answer from the options given below :
(1) (B) and (D) only
(2) (A), (C) and (D) only
(3) (A) only
(4) (A) and (C) only

Manipur NEET 2023

31. In which disorder change of single base pair in the gene for beta globin chain results in change of glutamic acid to valine?
(1) Thalassemia
(2) Sickle cell anemia
(3) Haemophilia
(4) Phenylketonuria

2023

32. Which one of the following symbols represents mating between relatives in human pedigree analysis?

(1) 
(2)
(3) 
(4) 

2023

33. Which of the following statements are correct about Klinefelter's Syndrome?
A. This disorder was first described by Langdon Down (1866).
B. Such an individual has overall masculine development. However, the feminine development is also expressed.
C. The affected individual is short statured.
D. Physical, psychomotor and mental development is retarded.
E. Such individuals are sterile.
Choose the correct answer from the options given below:
(1) B and E only
(2) A and E only
(3) A and B only
(4) C and D only

NODIA

2023

34. Broad palm with single palm crease is visible in a person suffering from
(1) Klinefelter's syndrome
(2) Thalassemia
(3) Down's syndrome
(4) Turner's syndrome.

2022

35. Given below are two statements :
Statement I : Mendel studied seven pairs of contrasting traits in pea plants and proposed the laws of inheritance.
Statement II : Seven characters examined by Mendel in his experiment on pea plants were seed shape and colour, flower colour, pod shape and colour, flower position and stem height.
In the light of the above statements, choose the correct answer from the options given below :
(1) Both Statement I and Statement II are correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is correct but Statement II is incorrect
(4) Statement I is incorrect but Statement II is correct

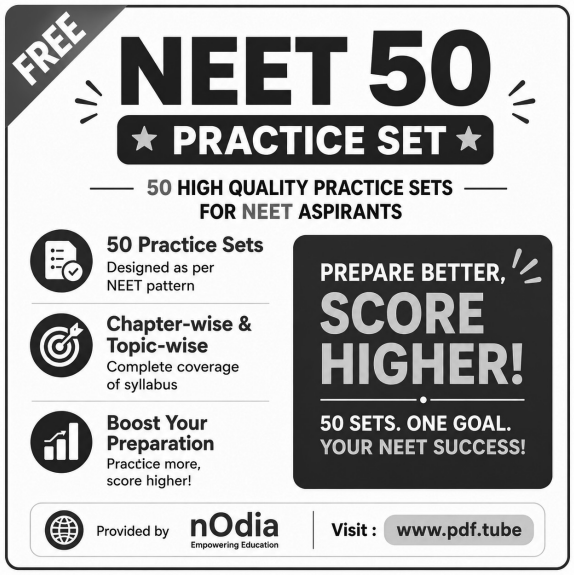
2022

36. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Mendel's law of independent assortment does not hold good for the genes that are located closely on the same chromosome.
Reason (R) : Closely located genes assort independently.

the womb of the mother where the gestation is completed.

The concept of a test-tube baby involves a multi-step medical process. First, the fertilisation of the egg is carried out in a laboratory, outside the female's body. Once successful fertilisation occurs and the embryo begins to develop, it is carefully placed into the mother's womb. There, the embryo attaches to the uterine wall and completes its full gestation period naturally.

www.nodia.in



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(2) This experiment does not follow the Principle of Dominance.
(3) Pink colour in F_1 is due to incomplete dominance.
(4) Ratio of F_2 is 1/4 (red) : 2/4 (pink) : 1/4 (white).

2019

48. What map unit (centimorgan) is adopted in the construction of genetic maps?
(1) A unit of distance between genes on chromosomes, representing 50% cross over.
(2) A unit of distance between two expressed genes, representing 10% cross over.
(3) A unit of distance between two expressed genes, representing 100% cross over.
(4) A unit of distance between genes on chromosomes, representing 1% cross over.

2019

49. The frequency of recombination between gene present on the same chromosome as a measure of the distance between genes was explained by
(1) Sutton Boveri
(2) T.H. Morgan
(3) Gregor J.Mendel
(4) Alfred Sturtevant.

2019

50. Select the incorrect statement.
(1) Human males have one of their sex-chromosome much shorter than other.
(2) Male fruit fly is heterogametic.
(3) In male grasshoppers, 50% of sperms have no sex-chromosome.
(4) In domesticated fowls, sex of progeny depends on the type of sperm rather than egg.

2019

51. What is the genetic disorder in which an individual has an overall masculine development, gynaecomastia and is sterile?
(1) Down's syndrome
(2) Turner's syndrome
(3) Klinefelter's syndrome
(4) Edward syndrome

2018

52. Which of the following characteristics represent 'inheritance of blood groups' in humans?
(i) Dominance
(ii) Co-dominance
(iii) Multiple allele
(iv) Incomplete dominance
(v) Polygenic inheritance
(1) (ii), (iii) and (v)
(2) (i), (ii) and (iii)
(3) (ii), (iv) and (v)
(4) (i), (iii) and (v)

2018

53. Which of the following pairs is wrongly matched?
(1) Starch synthesis in pea : Multiple alleles
(2) ABO blood grouping : Co-dominance
(3) XO type sex determination: Grasshopper
(4) T.H. Morgan : Linkage

2018

54. A woman has an X-linked condition on one of her X chromosomes. This chromosome can be inherited by
(1) only daughters
(2) only sons
(3) only grandchildren
(4) both sons and daughters.

NODIA

2017

55. Among the following characters, which one was not considered by Mendel in his experiments on pea?
(1) Trichomes-Glandular or non-glandular
(2) Seed-Green or yellow
(3) Pod-Inflated or constricted
(4) Stem-Tall or dwarf

2017

56. Which one from those given below is the period for Mendel's hybridisation experiments?
(1) 1840-1850
(2) 1857-1869
(3) 1870-1877
(4) 1856-1863

2017

57. The genotypes of a husband and wife are I^AI^B and I^Ai. Among the blood types of their children, how many different genotypes and phenotypes are possible?
(1) 3 genotypes; 4 phenotypes
(2) 4 genotypes; 3 phenotypes
(3) 4 genotypes; 4 phenotypes
(4) 3 genotypes; 3 phenotypes

2017

58. Thalassemia and sickle cell anaemia are caused due to a problem in globin molecule synthesis. Select the correct statement.
(1) Both are due to a quantitative defect in globin chain synthesis.

2014

80. A man whose father was colour blind marries a woman who had a colour blind mother and normal father. What percentage of male children of this couple will be colour blind?
(1) 25% (2) 0%
(3) 50% (4) 75%

2014

81. A human female with Turner's syndrome
(1) has 45 chromosomes with XO
(2) has one additional X chromosome
(3) exhibits male characters
(4) is able to produce children with normal husband.

2013

82. If two persons with 'AB' blood group marry and have sufficiently large number of children, these children could be classified as 'A' blood group : 'AB' blood group : 'B' blood group in 1 : 2 : 1 ratio. Modern technique of protein electrophoresis reveals presence of both 'A' and 'B' type proteins in 'AB' blood group individuals. This in an example of
(1) partial dominance
(2) complete dominance
(3) codominance
(4) incomplete dominance.

2013

83. Which idea is depicted by a cross in which the F_1 generation resembles both the parents?
(1) Inheritance of one gene
(2) Co-dominance
(3) Incomplete dominance
(4) Complete dominance

2013

84. Which of the following statements is not true of two genes that show 50% recombination frequency?
(1) The gene show independent assortment.
(2) If the genes are present on the same chromosome, they undergo more than one cross-overs in every meiosis.
(3) The genes may be on different chromosomes.
(4) The genes are tightly linked.

2013

85. Select the incorrect statement with regard to haemophilia.
(1) It is a dominant disease.
(2) A single protein involved in the clotting of blood is affected.
(3) It is a sex-linked disease.
(4) It is a recessive disease.

2013

86. If both parents are carriers for thalassaemia, which is an autosomal recessive disorder, what are the chances of pregnancy resulting in an affected child?
(1) 25%
(2) 100%
(3) No chance
(4) 50%

Karnataka NEET 2013

87. Which one is the incorrect statement with regard to the importance of pedigree analysis?
(1) It confirms that DNA is the carrier of genetic information.
(2) It helps to understand whether the trait in question is dominant or recessive.
(3) It confirms that the trait is linked to one of the autosome.
(4) It helps to trace the inheritance of a specific trait.

Karnataka NEET 2013

88. Down's syndrome in humans is due to
(1) three 'X' chromosomes
(2) three copies of chromosome 21
(3) monosomy
(4) two 'Y' chromosomes.

2012

89. F_2 generation in a Mendelian cross showed that both genotypic and phenotypic ratios are same as 1 : 2 : 1. It represents a case of
(1) co-dominance
(2) dihybrid cross
(3) monohybrid cross with complete dominance
(4) monohybrid cross with incomplete dominance.

Mains 2012

90. A test cross is carried out to
(1) determine the genotype of a plant at F_2
(2) predict whether two traits are linked
(3) assess the number of alleles of a gene
(4) determine whether two species or varieties will breed successfully.

2012

91. A normal-visioned man whose father was colour-blind, marries a woman whose father was also colour-blind. They have their first child as a daughter.

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2015 Cancelled

68. How many pairs of contrasting characters in pea plants were studied by Mendel in his experiments?
(1) Eight
(2) Seven
(3) Five
(4) Six

2015

69. A gene showing co-dominance has
(1) alleles that are recessive to each other
(2) both alleles independently expressed in the heterozygote
(3) one allele dominant on the other
(4) alleles tightly linked on the same chromosome.

2015 Cancelled

70. Alleles are
(1) different molecular forms of a gene
(2) heterozygotes
(3) different phenotype
(4) true breeding homozygotes.

2015 Cancelled

71. Multiple alleles are present
(1) at the same locus of the chromosome
(2) on non-sister chromatids
(3) on different chromosomes
(4) at different loci on the same chromosome.

2015 Cancelled

72. A man with blood group 'A' marries a woman with blood group 'B'. What are all the possible blood groups of their offspring?
(1) A, B, AB and O
(2) O only
(3) A and B only
(4) A, B and AB only

2015

73. The term "linkage" was coined by
(1) G. Mendel
(2) W. Sutton
(3) T.H. Morgan
(4) T. Boveri.

2015 Cancelled

74. The movement of a gene from one linkage group to another is called
(1) translocation
(2) crossing over
(3) inversion
(4) duplication.

2015

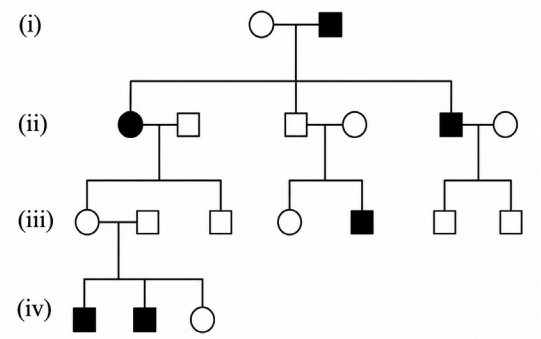
75. A pleiotropic gene
(1) controls a trait only in combination with another gene
(2) controls multiple traits in an individual
(3) is expressed only in primitive plants
(4) is a gene evolved during Pliocene.

2015

76. A colour blind man marries a woman with normal sight who has no history of colour blindness in her family. What is the probability of their grandson being colour blind ?
(1) Nil
(2) 0.25
(3) 0.5
(4) 1

2015

77. In the following human pedigree, the filled symbols represent the affected individuals. Identify the type of given pedigree.



(1) Autosomal recessive
(2) X-linked dominant
(3) Autosomal dominant
(4) X-linked recessive

2015 Cancelled

78. An abnormal human baby with 'XXX' sex chromosomes was born due to
(1) fusion of two ova and one sperm
(2) fusion of two sperms and one ovum
(3) formation of abnormal sperms in the father
(4) formation of abnormal ova in the mother.

2014

79. Fruit colour in squash is an example of
(1) recessive epistasis
(2) dominant epistasis
(3) complementary genes
(4) inhibitory genes.

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Mains 2010

101. A cross in which an organism showing a dominant phenotype is crossed with the recessive parent in order to know its genotype is called
(1) monohybrid cross
(2) back cross
(3) test cross
(4) dihybrid cross.

Mains 2010

102. In Antirrhinum two plants with pink flowers were hybridized. The F_1 plants produced red, pink and white flowers in the proportion of 1 red, 2 pink and 1 white. What could be the genotype of the two plants used for hybridisation? Red flower colour is determined by RR and white by rr genes.
(1) rrrr (2) RR
(3) Rr (4) rr

2010

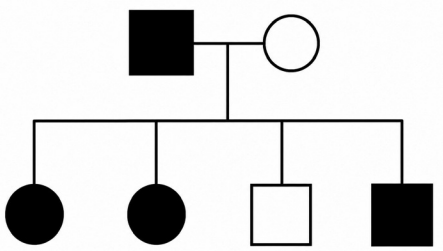
103. Select the correct statement from the ones given below with respect to dihybrid cross.
(1) Tightly linked genes on the same chromosomes show higher recombinations.
(2) Genes far apart on the same chromosome show very few recombinations.
(3) Genes loosely linked on the same chromosome show similar recombinations.
(4) Tightly linked genes on the same chromosome show very few recombinations.

2010

104. Which one of the following symbols and its representation, used in human pedigree analysis is correct?
(1) □═○ = Mating between relatives
(2) ○ = Unaffected male
(3) □ = Unaffected female
(4) ◆ = Male affected

Mains 2010

105. Study the pedigree chart of a certain family given below and select the correct conclusion which can be drawn for the character.



(1) The female parent is heterozygous.
(2) The parents could not have had a normal daughter for this character.
(3) The trait under study could not be colour blindness.
(4) The male parent is homozygous dominant.

2009

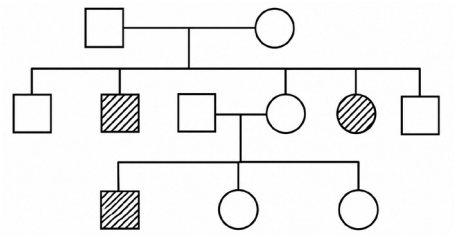
106. Select the incorrect statement from the following.
(1) Galactosemia is an inborn error of metabolism.
(2) Small population size results in random genetic drift in a population.
(3) Baldness is a sex-limited trait.
(4) Linkage is an exception to the principle of independent assortment in heredity.

2009

107. Sickle-cell anaemia is
(1) caused by substitution of valine by glutamic acid in the beta globin chain of haemoglobin
(2) caused by a change in a single base pair of DNA
(3) characterized by elongated sickle like RBCs with a nucleus
(4) an autosomal linked dominant trait.

2009

108. Study the pedigree chart given below. What does it show?



(1) Inheritance of a condition like phenylketonuria as an autosomal recessive trait.
(2) The pedigree chart is wrong as this is not possible.
(3) Inheritance of a recessive sex-linked disease like haemophilia.
(4) Inheritance of a sex-linked inborn error of metabolism like phenylketonuria.

NODIA

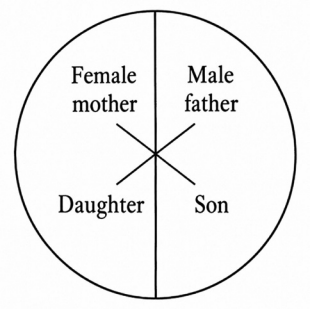
2008

109. Which one of the following conditions in humans is correctly matched with its chromosomal abnormality/linkage?
(1) Erythroblastosis fetalis - X-linked
(2) Down's syndrome - 44 autosomes + XO
(3) Klinefelter's syndrome - 44 autosomes + XXY
(4) Colour blindness - Y-linked

What are the chances that this child would be colour-blind?
(1) 100%
(2) Zero percent
(3) 25%
(4) 50%

Mains 2012

92. Represented here is the inheritance pattern of a certain type of trait in humans. Which one of the following conditions could be an example of this pattern?



(1) Phenylketonuria
(2) Sickle cell anaemia
(3) Haemophilia
(4) Thalassemia

Mains 2011

93. Test cross in plants or in Drosophila involves crossing
(1) between two genotypes with recessive trait
(2) between two F_1 hybrids
(3) the F_1 hybrid with a double recessive genotype
(4) between two genotypes with dominant trait.

2011

94. When two unrelated individuals or lines are crossed, the performance of F_1 hybrid is often superior to both its parents. This phenomenon is called
(1) heterosis
(2) transformation
(3) splicing
(4) metamorphosis.

Mains 2011

95. Which one of the following conditions of the zygotic cell would lead to the birth of a normal human female child?
(1) Two X chromosomes
(2) Only one Y chromosome
(3) Only one X chromosome
(4) One X and one Y chromosome

2011

96. Which one of the following conditions correctly describes the manner of determining the sex?
(1) Homozygous sex chromosomes (ZZ) determine female sex in birds.
(2) XO type of sex chromosomes determine male sex in grasshopper.
(3) XO condition in humans as found in Turner's syndrome, determines female sex.
(4) Homozygous sex chromosomes (XX) produce male in Drosophila.

2010

97. ABO blood groups in humans are controlled by the gene I. It has three alleles - I^A, I^B and i. Since there are three different alleles, six different genotypes are possible. How many phenotypes can occur?
(1) Three
(2) One
(3) Four
(4) Two

2010

98. The genotype of a plant showing the dominant phenotype can be determined by
(1) test cross
(2) dihybrid cross
(3) pedigree analysis
(4) back cross.

2010

99. Which one of the following cannot be explained on the basis of Mendel's law of dominance?
(1) The discrete unit controlling a particular character is called a factor.
(2) Out of one pair of factors one is dominant, and the other recessive.
(3) Alleles do not show any blending and both the characters recover as such in F_2 generation.
(4) Factors occur in pairs.

Mains 2010

100. ABO blood grouping is controlled by gene I which has three alleles and show co-dominance. There are six genotypes. How many phenotypes in all are possible?
(1) Six
(2) Three
(3) Four
(4) Five

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2006

122. Sickle cell anaemia has not been eliminated from the African population because
(1) it is controlled by dominant genes
(2) it is controlled by recessive genes
(3) it is not a fatal disease
(4) it provides immunity against malaria.

2005

123. In order to find out the different types of gametes produced by a pea plant having the genotype AaBb it should be crossed to a plant with the genotype
(1) AABB (2) AaBb
(3) aabb (4) aaBB.

2005

124. A man and a woman, who do not show any apparent signs of a certain inherited disease, have seven children (2 daughters and 5 sons). Three of the sons suffer from the given disease but none of the daughters affected. Which of the following mode of inheritance do you suggest for this disease?
(1) Sex-linked dominant
(2) Sex-linked recessive
(3) Sex-limited recessive
(4) Autosomal dominant

2005

125. A woman with 47 chromosomes due to three copies of chromosome 21 is characterised by
(1) superfemaleness
(2) triploidy
(3) Turner's syndrome
(4) Down's syndrome.

2005

126. Haemophilia is more commonly seen in human males than in human females because
(1) a greater proportion of girls die in infancy
(2) this disease is due to a Y-linked recessive mutation
(3) this disease is due to an X-linked recessive mutation
(4) this disease is due to an X-linked dominant mutation.

2005

127. Which of the following is not a hereditary disease?
(1) Cystic fibrosis
(2) Thalassaemia
(3) Haemophilia
(4) Cretinism

2005

128. A woman with normal vision, but whose father was colour blind, marries a colour blind man. Suppose that the fourth child of this couple was a boy. This boy
(1) may be colour blind or may be of normal vision
(2) must be colour blind
(3) must have normal colour vision
(4) will be partially colour blind since he is heterozygous for the colour blind mutant allele.

2004

129. In a plant, red fruit (R) is dominant over yellow fruit (r) and tallness (T) is dominant over shortness (t). If a plant with RRTt genotype is crossed with a plant that is rrtt,
(1) 25% will be tall with red fruit
(2) 50% will be tall with red fruit
(3) 75% will be tall with red fruit
(4) all the offspring will be tall with red fruit.

2004

130. Lack of independent assortment of two genes A and B in fruit fly Drosophila is due to
(1) repulsion
(2) recombination
(3) linkage
(4) crossing over.

2004

131. One of the parents of a cross has a mutation in its mitochondria. In that cross, that parent is taken as a male. During segregation of F_2 progenies that mutation is found in
(1) one-third of the progenies
(2) none of the progenies
(3) all the progenies
(4) fifty percent of the progenies.

2004

132. A male human is heterozygous for autosomal genes A and B and is also hemizygous for haemophilic gene h. What proportion of his sperms will be abh?
(1) 1/8
(2) 1/32
(3) 1/16
(4) 1/4

2004

133. A normal woman, whose father was colour-blind is married to a normal man. The sons would be
(1) 75% colour-blind
(2) 50% colour-blind

NODIA

2007

110. In pea plants, yellow seeds are dominant to green. If a heterozygous yellow seeded plant is crossed with a green seeded plant, what ratio of yellow and green seeded plants would you expect in F_1 generation?
(1) 9 : 1
(2) 1 : 3
(3) 3 : 1
(4) 50 : 50

2007

111. A common test to find the genotype of a hybrid is by
(1) crossing of one F_2 progeny with female parent
(2) studying the sexual behaviour of F_1 progenies
(3) crossing of one F_1 progeny with male parent
(4) crossing of one F_2 progeny with male parent.

2007

112. A human male produces sperms with the genotypes AB, Ab, aB and ab pertaining to two diallelic characters in equal proportions. What is the corresponding genotype of this person?
(1) AaBB
(2) AABb
(3) AABB
(4) AaBb

2007

113. Inheritance of skin colour in humans is an example of
(1) point mutation
(2) polygenic inheritance
(3) codominance
(4) chromosomal aberration.

2006

114. Test cross involves
(1) crossing between two genotypes with dominant trait
(2) crossing between two genotypes with recessive trait
(3) crossing between two F_1 hybrids
(4) crossing the F_1 hybrid with a double recessive genotype.

2006

115. Phenotype of an organism is the result of
(1) genotype and environment interactions
(2) mutations and linkages
(3) cytoplasmic effects and nutrition
(4) environmental changes and sexual dimorphism.

2006

116. In Mendel's experiments with garden pea, round seed shape (RR) was dominant over wrinkled seeds (rr), yellow cotyledon (YY) was dominant over green cotyledon (yy). What are the expected phenotypes in the F_2 generation of the cross RRYY × rryy?
(1) Round seeds with yellow cotyledons, and wrinkled seeds with yellow cotyledons
(2) Only round seeds with green cotyledons
(3) Only wrinkled seeds with yellow cotyledons
(4) Only wrinkled seeds with green cotyledons

2006

117. How many different kinds of gametes will be produced by a plant having the genotype AABbCC?
(1) Two
(2) Three
(3) Four
(4) Nine

2006

118. Which one of the following is an example of polygenic inheritance?
(1) Skin colour in humans
(2) Flower colour in Mirabilis jalapa
(3) Production of male honeybee
(4) Pod shape in garden pea

2006

119. Both sickle cell anaemia and Huntington's chorea are
(1) virus-related diseases
(2) bacteria-related diseases
(3) congenital disorders
(4) pollutant-induced disorders.

2006

120. If a colour blind woman marries a normal visioned man, their sons will be
(1) all colour blind
(2) all normal visioned
(3) one-half colour blind and one-half normal
(4) three-fourths colour blind and one-fourth normal.

2006

121. Cri-du-chat syndrome in humans is caused by the
(1) trisomy of 21st chromosome
(2) fertilisation of an XX egg by a normal Y-bearing sperm
(3) loss of half of the short arm of chromosome 5
(4) loss of half of the long arm of chromosome 5.

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(2) Thalassemia is due to less synthesis of globin molecules.
(3) Sickle cell anaemia is due to a quantitative problem of globin molecules.
(4) Both are due to a qualitative defect in globin chain synthesis.

2017

59. A disease caused by an autosomal primary non-disjunction is
(1) Klinefelter's syndrome
(2) Turner's syndrome
(3) Sickle cell anaemia
(4) Down's syndrome.

NEET-I 2016

60. A tall true breeding garden pea plant is crossed with a dwarf true breeding garden pea plant. When the F_1 plants were selfed the resulting genotypes were in the ratio of
(1) 3 : 1 : : Tall : Dwarf
(2) 3 : 1 : : Dwarf : Tall
(3) 1 : 2 : 1 : : Tall homozygous : Tall heterozygous : Dwarf
(4) 1 : 2 : 1 : : Tall heterozygous : Tall homozygous : Dwarf.

NEET-II 2016

61. The mechanism that causes a gene to move from one linkage group to another is called
(1) inversion (2) duplication
(3) translocation (4) crossing-over.

NEET-I 2016

62. In a test cross involving F_1 dihybrid flies, more parental-type offspring were produced than the recombinant-type offspring. This indicates
(1) the two genes are linked and present on the same chromosome
(2) both of the characters are controlled by more than one gene
(3) the two genes are located on two different chromosomes
(4) chromosomes failed to separate during meiosis.

NEET-I 2016

63. Match the terms in column I with their description in column II and choose the correct option.

	Column I		Column II
A.	Dominance	(i)	Many genes govern a single character
B.	Co-dominance	(ii)	In a heterozygous organism only one allele expresses itself
C.	Pleiotropy	(iii)	In a heterozygous organism both alleles express themselves fully
D.	Polygenic	(iv)	A single gene inheritance influences many characters

(1) A-(iv); B-(i); C-(ii); D-(iii)
(2) A-(iv); B-(iii); C-(i); D-(ii)
(3) A-(ii); B-(i); C-(iv); D-(iii)
(4) A-(ii); B-(iii); C-(iv); D-(i)

NEET-II 2016

64. If a colour-blind man marries a woman who is homozygous for normal colour vision, the probability of their son being colour-blind is
(1) 0
(2) 0.5
(3) 0.75
(4) 1.

NEET-I 2016

65. Pick out the correct statements.
A. Haemophilia is a sex-linked recessive disease.
B. Down's syndrome is due to aneuploidy.
C. Phenylketonuria is an autosomal recessive gene disorder.
D. Sickle cell anaemia is an X-linked recessive gene disorder.
(1) (A), (C) and (D) are correct.
(2) (A), (B) and (C) are correct.
(3) (A) and (D) are correct.
(4) (B) and (D) are correct.

NEET-I 2016

66. Which of the following most appropriately describes haemophilia?
(1) Chromosomal disorder
(2) Dominant gene disorder
(3) Recessive gene disorder
(4) X-linked recessive gene disorder

NODIA

2015

67. In his classic experiments on pea plants, Mendel did not use
(1) seed shape
(2) flower position
(3) seed colour
(4) pod length.

(3) all normal
(4) all colour-blind.

2004

134. The recessive genes located on X-chromosome humans are always
(1) lethal
(2) sub-lethal
(3) expressed in males
(4) expressed in females.

2003

135. Which one of the following traits of garden pea studied by Mendel was a recessive feature?
(1) Axial flower position
(2) Green seed colour
(3) Green pod colour
(4) Round seed shape

2003

136. The genes controlling the seven pea characters studied by Mendel are now known to be located on how many different chromosomes?
(1) Seven
(2) Six
(3) Five
(4) Four

2003

137. Two crosses between the same pair of genotypes or phenotypes in which the sources of the gametes are reversed in one cross, is known as
(1) test cross
(2) reciprocal cross
(3) dihybrid cross
(4) reverse cross.

2003

138. In Drosophila, the sex is determined by
(1) the ratio of number of X-chromosome to the sets of autosomes
(2) X and Y chromosomes
(3) the ratio of pairs of X-chromosomes to the pairs of autosomes
(4) whether the egg is fertilized or develops parthenogenetically.

2003

139. Pattern baldness, moustaches and beard in human males are examples of
(1) sex linked traits
(2) sex limited traits
(3) sex influenced traits
(4) sex determining traits.

2003

140. Which one of the following conditions though harmful in itself, is also potential saviour from a mosquito borne infectious disease ?
(1) Thalassaemia
(2) Sickle cell anaemia
(3) Pernicious anaemia
(4) Leukaemia

2003

141. Down's syndrome is caused by an extra copy of chromosome number 21. What percentage of offspring produced by an affected mother and a normal father would be affected by this disorder?
(1) 100%
(2) 75%
(3) 50%
(4) 25%

2003

142. Christmas disease is another name for
(1) haemophilia B
(2) hepatitis B
(3) Down's syndrome
(4) sleeping sickness.

2002

143. A gene is said to be dominant if
(1) it expresses its effect only in homozygous state
(2) it expresses its effect only in heterozygous condition
(3) it expresses its effect both in homozygous and heterozygous condition
(4) it never expresses its effect in any condition.

2002

144. There are three genes a, b, c. Percentage of crossing over between a and b is 20%, b and c is 28% and a and c is 8%. What is the sequence of genes on chromosome?
(1) b, a, c
(2) a, b, c
(3) a, c, b
(4) None of these

2002

145. On selfing a plant of F_1-generation with genotype "AABbCC", the genotypic ratio in F_2-generation will be
(1) 3 : 1
(2) 1 : 1
(3) 9 : 3 : 3 : 1
(4) 27 : 9 : 9 : 9 : 3 : 3 : 3 : 1.

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2002

146. Which of the following is an example of pleiotropy?
(1) Haemophilia
(2) Thalassemia
(3) Sickle cell anaemia
(4) Colour blindness

2002

147. A diseased man marries a normal woman. They get three daughters and five sons. All the daughters were diseased and sons were normal. The gene of this disease is
(1) sex linked dominant
(2) sex linked recessive
(3) sex limited character
(4) autosomal dominant.

2002

148. Which of the following is a correct match?
(1) Down's syndrome - 21st chromosome
(2) Sickle cell anaemia - X-chromosome
(3) Haemophilia - Y-chromosome
(4) Parkinson's disease - X and Y chromosome

2001

149. When dominant and recessive alleles express itself together it is called
(1) co-dominance
(2) dominance
(3) amphidominance
(4) pseudodominance.

2001

150. Two non-allelic genes produces the new phenotype when present together but fail to do so independently then it is called
(1) epistasis
(2) polygene
(3) non complementary gene
(4) complementary gene.

2001

151. A and B genes are linked. What shall be genotype of progeny in a cross between AB/ab and ab/ab?
(1) AAbb and aabb
(2) AaBb and aabb
(3) AABB and aabb
(4) None of these

2001

152. Ratio of complementary genes is
(1) 9 : 3 : 4
(2) 12 : 3 : 1
(3) 9 : 3 : 3 : 4
(4) 9 : 7.

2001

153. Independent assortment of genes does not take place when
(1) genes are located on homologous chromosomes
(2) genes are linked and located on same chromosome
(3) genes are located on non-homogenous chromosome
(4) all of these.

2001

154. Number of Barr bodies in XXXX female is
(1) 1 (2) 2
(3) 3 (4) 4.

2001

155. Male XX and female XY sometime occur due to
(1) deletion
(2) transfer of segments in X and Y chromosome
(3) aneuploidy
(4) hormonal imbalance.

2001

156. Probability of four sons to a couple is
(1) 1/4 (2) 1/8
(3) 1/16 (4) 1/32.

2001

157. Sickle cell anaemia induce to
(1) change of amino acid in α-chain of haemoglobin
(2) change of amino acid in β-chain of haemoglobin
(3) change of amino acid in both α and β chains of haemoglobin
(4) change of amino acid either α or β chains of haemoglobin.

NODIA

2000

158. According to Mendelism, which character shows dominance?
(1) Terminal position of flower
(2) Green colour in seed coat
(3) Wrinkled seeds
(4) Green pod colour

2000

159. Due to the cross between TTRr $\times$ ttrr the resultant progenies show what percent of tall, red flowered plants?
(1) 50%
(2) 75%
(3) 25%
(4) 100%

2000

160. Mongolian Idiocy due to trisomy in 21st chromsome is called
(1) Down's syndrome
(2) Turner's syndrome
(3) Klinefelter's syndrome
(4) Triple X syndrome.

2000

161. In Drosophila, the XXY condition leads to femaleness whereas in human beings the same condition leads to Klinefelter's syndrome in male. It proves
(1) in human beings Y chromosome is active in sex determination
(2) Y chromosome is active in sex determination in both human beings and Drosophila
(3) in Drosophila Y chromosome decides femaleness
(4) Y chromosome of man have genes for syndrome.

1999

162. In hybridisation, Tt × tt gives rise to the progeny of ratio
(1) 2 : 1
(2) 1 : 2 : 1
(3) 1 : 1
(4) 1 : 2.

1999

163. A gene pair hides the effect of another gene. The phenomenon is called
(1) dominance
(2) segregation
(3) epistasis
(4) mutation.

1999

164. In human beings, multiple genes are involved in the inheritance of
(1) sickle-cell anaemia
(2) skin colour
(3) colour blindness
(4) phenylketonuria.

1999

165. A marriage between normal visioned man and colour blind woman will produce offspring
(1) colour blind sons and 50% carrier daughter
(2) 50% colourblind sons and 50% carrier daughter
(3) normal males and carrier daughters
(4) colour blind sons and carrier daughters.

1999

166. Haemophilic man marries a normal woman. Their offspring will be
(1) all haemophilic
(2) all boys haemophilic
(3) all girls haemophilic
(4) all normal.

1998

167. If Mendel had studied the seven traits using a plant with 12 chromosomes instead of 14, in what way would his interpretation have been different?
(1) He would not have discovered the law of independent assortment.
(2) He would have discovered sex linkage.
(3) He could have mapped the chromosome.
(4) He would have discovered blending or incomplete dominance.

1998

168. Crossing over in diploid organism is responsible for
(1) segregation of alleles
(2) recombination of linked alleles
(3) dominance of genes
(4) linkage between genes.

1998

169. How many different types of genetically different gametes will be produced by a heterozygous plant having the genotype AABbCc?
(1) Six (2) Nine
(3) Two (4) Four

NODIA

1998

170. When a single gene influences more than one trait it is called
(1) pseudodominance
(2) pleiotropy
(3) epistasis
(4) none of these.

1998

171. A woman with two genes for haemophilia and one gene for colour blindness on one of the 'X' chromosomes marries a normal man. How will the progeny be?
(1) 50% haemophilic colour-blind sons and 50% haemophilic sons.
(2) 50% haemophilic daughters (carrier) and 50% colour blind daughters (carrier).
(3) All sons and daughters haemophilic and colour-blind.
(4) Haemophilic and colour-blind daughters.

1998

172. Mental retardation in man, associated with sex chromosomal abnormality is usually due to
(1) moderate increase in Y complement
(2) large increase in Y complement
(3) reduction in X complement
(4) increase in X complement.

1998

173. Albinism is known to be due to an autosomal recessive mutation. The first child of a couple with normal skin pigmentation was an albino. What is the probability that their second child will also be an albino?
(1) 50%
(2) 75%
(3) 100%
(4) 25%

1997

174. A fruit fly is heterozygous for sex-linked genes, when mated with normal female fruit fly, the males specific chromosome will enter egg cell in the proportion
(1) 3 : 1
(2) 7 : 1
(3) 1 : 1
(4) 2 : 1.

1997

175. Genetic identity of a human male is determined by
(1) sex-chromosome
(2) cell organelles
(3) autosome
(4) nucleolus.

1997

176. A person with the sex chromosomes XXY suffers from
(1) gynandromorphism
(2) Klinefelter's syndrome
(3) Down's syndrome
(4) Turner's syndrome.

1996

177. When two dominant independently assorting genes react with each other, they are called
(1) collaborative genes
(2) complementary genes
(3) duplicate genes
(4) supplementary genes.

1996

178. The polygenic genes show
(1) different karyotypes
(2) different genotypes
(3) different phenotypes
(4) none of these.

1996

179. When an animal has both the characters of male and female, it is called
(1) super female
(2) super male
(3) intersex
(4) gynandromorph.

1996

180. In which of the following diseases, the man has an extra X-chromosome?
(1) Turner's syndrome
(2) Klinefelter's syndrome
(3) Down's syndrome
(4) Haemophilia

1996

181. A person whose father is colour blind marries a lady whose mother is daughter of a colour blind man. Their children will be
(1) all sons colour blind
(2) some sons normal and some colour blind
(3) all colour blind
(4) all daughters normal.

1996

182. A genetically diseased father (male) marries with a normal female and gives birth to 3 carrier girls and 5 normal sons. It may be which type of genetic disease?
(1) Sex-influenced disease
(2) Blood group inheritance disease
(3) Sex-linked disease
(4) Sex-recessive disease

1995

183. When two genetic loci produce identical phenotypes in cis and trans position, they are considered to be
(1) multiple alleles
(2) the parts of same gene
(3) pseudoalleles
(4) different genes.

1995

184. The phenomenon, in which an allele of one gene suppresses the activity of an allele of another gene, is known as
(1) epistasis
(2) dominance
(3) suppression
(4) inactivation.

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1995

185. The most striking example of point mutation is found in a disease called
(1) Down's syndrome
(2) sickle cell anaemia
(3) thalassaemia
(4) night blindness.

1995

186. An abnormal human male phenotype involving an extra X-chromosome (XXY) is a case of
(1) Edward's syndrome
(2) Klinefelter's syndrome
(3) intersex
(4) Down's syndrome.

1994

187. A child's blood group is 'O'. The parent's blood groups cannot be
(1) A and B
(2) A and A
(3) AB and O
(4) B and O.

1994

188. The genes, which remain confined to differential region of Y-chromosome, are
(1) autosomal genes
(2) holandric genes
(3) completely sex-linked genes
(4) mutant genes.

1994

189. Albinism is a congenital disorder resulting from the lack of which enzyme?
(1) Tyrosinase
(2) Xanthine oxidase
(3) Catalase
(4) Fructokinase

1994

190. The colour blindness is more likely to occur in males than in females because
(1) the Y-chromosome of males have the genes for distinguishing colours
(2) genes for characters are located on the sex-chromosomes
(3) the trait is dominant in males and recessive in females
(4) none of these.

1993

191. Which of the following is suitable for experiment on linkage?
(1) aaBB × aaBB
(2) AABB × aabb
(3) AaBb × AaBb
(4) AAbb × AaBB

1993

192. Two dominant nonallelic genes are 50 map units apart. The linkage is
(1) cis type
(2) trans type
(3) complete
(4) absent/incomplete.

1993

193. Mendel studied inheritance of seven pairs of traits in pea which can have 21 possible combinations. If you are told that in one of these combinations, independent assortment is not observed in later studies, your reaction will be
(1) independent assortment principle may be wrong
(2) Mendel might not have studied all the combinations
(3) it is impossible
(4) later studies may be wrong.

1993

194. A polygenic inheritance in human beings is
(1) skin colour
(2) phenylketonuria
(3) colour blindness
(4) sickle cell anaemia.

1993

195. Mr. Kapoor has Bb autosomal gene pair and d allele sex-linked. What shall be proportion of Bd in sperms?
(1) Zero
(2) 1/2
(3) 1/4
(4) 1/8

1993

196. Sex is determined in human beings
(1) by ovum
(2) at time of fertilisation
(3) 40 days after fertilisation
(4) seventh to eight week when genitals differentiate in fetus.

1993

197. Of both normal parents, the chances of a male child becoming colour blind are
(1) none
(2) possible only when all the four grand parents had normal vision
(3) possible only when father's mother was colour blind

NODIA

(4) possible only when mother's father was colour blind.

1993

198. Of a normal couple, half the sons are haemophiliac while half the daughters are carriers. The gene is located on
(1) X-chromosome of father
(2) Y-chromosome of father
(3) one X-chromosome of mother
(4) both the X-chromosomes of mother.

1992

199. A child of O-group has B-group father. The genotype of father will be
(1) I^OI^O
(2) I^BI^B
(3) I^AI^B
(4) I^BI^O.

1992

200. An allele is dominant if it is expressed in
(1) both homozygous and heterozygous states
(2) second generation
(3) heterozygous combination
(4) homozygous combination.

1992

201. An organism with two identical alleles is
(1) dominant
(2) hybrid
(3) heterozygous
(4) homozygous.

1992

202. In a cross between AABB $\times$ aabb, the ratio of F_2 genotypes between AABB, AaBB, Aabb and aabb would be
(1) 9 : 3 : 3 : 1
(2) 2 : 1 : 1 : 2
(3) 1 : 2 : 2 : 1
(4) 7 : 5 : 3 : 1.

1992

203. Segregation of Mendelian factors (no linkage, no crossing over) occurs during
(1) anaphase I
(2) anaphase II
(3) diplotene
(4) metaphase I.

1992

204. A colour blind mother and normal father would have
(1) colour blind sons and normal/carrier daughters
(2) colour blind sons and daughters
(3) all colour blind
(4) all normal.

1992

205. Down's syndrome is due to
(1) crossing over
(2) linkage
(3) sex-linked inheritance
(4) non-disjunction of chromosomes.

1992

206. In human beings 45 chromosomes/single X/XO abnormality causes
(1) Down's syndrome
(2) Kinefelter's syndrome
(3) Turner's syndrome
(4) Edward's syndrome

1991

207. First geneticist/father of genetics was
(1) De Vries
(2) Mendel
(3) Darwin
(4) Morgan.

1991

208. A man of A-blood group marries a woman of AB blood group. Which type of progeny would indicate that man is heterozygous A?
(1) AB
(2) A
(3) O
(4) B

1991

209. Multiple alleles control inheritance of
(1) phenylketonuria
(2) colour blindness
(3) sickle cell anaemia
(4) blood groups.

1991

210. The contrasting pairs of factors in Mendelian crosses are called
(1) multiple alleles
(2) allelomorphs
(3) alloloci
(4) paramorphs.

1991

211. Mendel's last law is
(1) segregation
(2) dominance
(3) independent assortment
(4) polygenic inheritance.

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1991

212. Blue eye colour is recessive to brown eye colour. A brown eyed man whose mother was blue eyed marries a blue-eyed woman. The children will be
(1) both blue eyed and brown eyed 1 : 1
(2) all brown eyed
(3) all blue eyed
(4) blue eyed and brown eyed 3 : 1.

1991

213. RR (Red) Antirrhinum is crossed with white (WW) one. Offspring RW are pink. This is an example of
(1) dominant-recessive
(2) incomplete dominance
(3) hybrid
(4) supplementary genes.

1991

214. The allele which is unable to express its effect in the presence of another is called
(1) codominant
(2) supplementary
(3) complementary
(4) recessive.

1991

215. A colour blind girl is rare because she will be born only when
(1) her mother and maternal grand father were colour blind
(2) her father and maternal grand father were colour blind
(3) her mother is colour blind and father has normal vision
(4) parents have normal vision but grand parents were colour blind.

1990

216. ABO blood group system is due to
(1) multifactor inheritance
(2) incomplete dominance
(3) multiple allelism
(4) epistasis.

1990

217. tt mates with Tt. What will be characteristic of offspring?
(1) 75% recessive
(2) 50% recessive
(3) 25% recessive
(4) All dominant

1990

218. Cross between AaBB and aaBB will form
(1) 1AaBB : 1aaBB
(2) all AaBB
(3) 3AaBB : 1aaBB
(4) 1AaBB : 3aaBB.

1990

219. In a genetic cross having recessive epistasis, F_2 phenotypic ratio would be
(1) 9 : 6 : 1
(2) 15 : 1
(3) 9 : 3 : 4
(4) 12 : 3 : 1.

1990

220. Bateson used the terms coupling and repulsion for linkage and crossing over. Name the correct parental of coupling type alongwith its cross over or repulsion.
(1) Coupling AABB, aabb; Repulsion AABB, aabb
(2) Coupling AAbb, aaBB; Repulsion AaBb, aabb
(3) Coupling aaBB, aabb; Repulsion AABB, aabb
(4) Coupling AABB, aabb; Repulsion AAbb, aaBB

1990

221. Segregation of Mendelian factor (Aa) occurs during
(1) diplotene
(2) anaphase I
(3) zygotene/pachytene
(4) anaphase II.

1990

222. In Down's syndrome of a male child, the sex complement is
(1) XO
(2) XY
(3) XX
(4) XXY.

1990

223. Haemophilia is more common in males because it is a
(1) recessive character carried by Y-chromosome
(2) dominant character carried by Y-chromosome
(3) dominant trait carried by X-chromosome
(4) recessive trait carried by X-chromosome.

1990

224. Which one is a hereditary disease?
(1) Cataract
(2) Leprosy
(3) Blindness
(4) Phenylketonuria

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12. (4) 1/2
In an X-linked recessive trait, a carrier female and an unaffected male produce offspring where sons have a fifty percent chance of being affected and daughters have a fifty percent chance of being carriers. The probability calculation depends on the genotypes of the parents in the preceding generation and the segregation of sex chromosomes during gametogenesis.

13. (2) A, C, D and E only
Mendel's Law of Dominance states that characters are controlled by discrete units called factors which occur in pairs. In a dissimilar pair, one member dominates the other. This explains why only one parental trait appears in the first filial generation, while both traits are recovered in the second filial generation during a typical monohybrid cross experiment.

14. (4) B and E
The ABO blood group system is determined by three alleles of a single gene. An A group mother can be homozygous or heterozygous, and a B group father can also be heterozygous. For a child to have blood group A, the father must contribute the recessive allele, and the mother must contribute the dominant A allele.

15. (1) A only
For a child to express the O blood group, which is a recessive phenotype, both parents must carry the recessive i allele. Therefore, a father with blood group B must have a heterozygous genotype, and a mother with blood group A must also be heterozygous. This genetic combination allows for the inheritance of two recessive alleles.

16. (2) Red flowered as well as pink flowered plants
In Snapdragon, flower color exhibits incomplete dominance where the heterozygous genotype produces a pink phenotype. Crossing a pink plant with a red plant results in a progeny where half the plants are homozygous red and the other half are heterozygous pink. This occurs because the red allele is not completely dominant over the white allele in this species.

17. (2) bb
To determine the unknown genotype of an organism expressing a dominant phenotype, it is crossed with a homozygous recessive individual. This procedure is known as a test cross. If the offspring show only the dominant trait, the parent is homozygous. If half show the recessive trait, the parent is heterozygous for that specific seed color trait.

18. (3) A-III, B-IV, C-I, D-II
Different forms of a gene are called alleles. A test cross involves mating an individual with a homozygous recessive parent to reveal its genotype. A back cross refers to crossing a progeny with any of its parents. Ploidy describes the number of complete sets of chromosomes present in the cells of an organism or plant species.

19. (4) TTRr
The production of both round and wrinkled seeds from a round-seeded parent indicates that the parent is heterozygous for the seed shape trait. However, since no dwarf plants were produced, the parent must be homozygous for the tallness trait. This genetic configuration ensures all offspring remain tall while allowing segregation for the recessive wrinkled seed shape trait.

20. (2) Statement I is false but statement II is true.
Polygenic inheritance involves traits controlled by three or more genes, whereas multiple allelism involves more than two alleles of a single gene. In polygenic systems, the phenotype reflects the total contribution of each allele, meaning the effect is additive. This differs from Mendelian inheritance where one allele usually shows complete dominance over another in a single gene pair.

21. (2) A-II, B-I, C-IV, D-III
Flower color in Snapdragon represents incomplete dominance, while human ABO blood groups illustrate co-dominance. Phenylketonuria is an example of pleiotropy because a single gene mutation affects multiple systems. Human skin color follows a polygenic inheritance pattern where multiple genes contribute to a single trait, resulting in a wide range of phenotypic variations across the human population.

22. (4) B and C only
Aneuploidy refers to the presence of an abnormal number of chromosomes in a cell. This condition arises due to the failure of chromatid segregation during cell division, leading to the addition or deletion of specific chromosomes. Common examples include trisomy or monosomy, where individuals possess more or fewer chromosomes

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ANSWERS

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1. (4) Both Statement I and Statement II are incorrect
Down's syndrome is caused by an additional copy of chromosome 21 (trisomy 21), not the absence of an X-chromosome, so Statement I is wrong. Turner's syndrome is caused by the absence of one X-chromosome (XO), not an extra chromosome, so Statement II is wrong.

2. (2) Father: IAIB and Mother: IAi
A person with O group is genotype ii and must inherit one i allele from each parent. A father with IAIB has no i allele, so he cannot pass an i to the child. Hence this combination cannot produce an O-group child.

3. (3) Both A and R are correct and R is the correct explanation of A
In Mendel's monohybrid cross of tall and dwarf pea plants, all F1 plants were tall (A correct). This happened because tall is dominant over recessive dwarf (R correct). Since dominance of tall explains why all F1 were tall, R explains A.

4. (1) A-II, B-IV, C-III, D-I
Incomplete dominance is seen in flower colour of Antirrhinum (snapdragon). Co-dominance is shown by ABO blood groups. Pleiotropy is illustrated by phenylketonuria, where one gene affects many traits. Polygenic inheritance controls human skin colour through multiple genes. This gives A-II, B-IV, C-III, D-I.

5. (1) A, B, C and E only
In honeybees, fertilised eggs become diploid females (A), unfertilised eggs become haploid males by parthenogenesis (B), males have half the chromosome number (C), and the system is haplodiploid (E). Males being haploid cannot undergo normal meiosis to form sperm, so D is incorrect.

6. (2) Sickle-cell anaemia
Sickle-cell anaemia is an autosomal recessive disorder caused by substitution of glutamic acid by valine at the sixth position of the beta globin chain. This point mutation changes haemoglobin to HbS, causing red blood cells to become sickle-shaped under low oxygen conditions.

7. (2) 0%
A mother of O blood group has genotype ii, while a father heterozygous for A and B is IA IB. The cross ii x IA IB gives offspring that are IAi (group A) and IBi (group B) only. No offspring inherits two i alleles, so the probability of O group children is zero.

8. (3) males and females, respectively
Grasshoppers show XO type of sex determination. Females have a pair of sex chromosomes (XX) giving an even diploid number (24), while males have only one X (XO), giving one less, that is 23 chromosomes. Hence the 23-chromosome members are males and the 24-chromosome members are females.

9. (1) Male honeybees
Male honeybees (drones) develop from unfertilised eggs by parthenogenesis and are haploid. Since their body cells are already haploid, they cannot undergo meiosis; instead these haploid cells divide mitotically to produce gametes (sperm). This is a unique feature of the haplodiploid sex-determination system in honeybees.

10. (1) Phenotypic ratio - 9 : 3 : 3 : 1
Independent assortment of two genes results in the classic dihybrid phenotypic ratio. When RRYY is crossed with rryy, the F_1 generation is RrYy. Selfing the F_1 generation produces sixteen possible zygotic combinations. These combinations express four distinct phenotypes in a predictable frequency based on dominance and random alignment of alleles during meiosis.

11. (4) Non-mendelian inheritance pattern
Polygenic traits are controlled by multiple genes at different loci, where each allele has a small additive effect on the phenotype. Unlike Mendelian traits that follow discrete categories, these traits show continuous variation. Therefore, they fall under non-Mendelian inheritance patterns because the interaction of several genes deviates from the standard single-gene dominance models.

horizontal lines are drawn between the symbols, it specifically indicates consanguineous mating, which is marriage or mating between closely related individuals within the same family tree or lineage.

33. (1) B and E only
Klinefelter's syndrome is a chromosomal disorder caused by the presence of an additional X chromosome in males. These individuals exhibit overall masculine development, but feminine traits like gynecomastia are also expressed. Furthermore, such individuals are sterile due to underdeveloped testes. The syndrome was first described by Harry Klinefelter, while Langdon Down described a different condition involving the twenty-first chromosome.

34. (3) Down's syndrome
Down's syndrome is a genetic disorder resulting from the trisomy of chromosome twenty-one. Characteristic physical features of affected individuals include a short stature, a small round head, and a furrowed tongue. Additionally, they often possess a broad palm with a distinct single palmar crease. These physical markers are helpful diagnostic indicators alongside developmental delays and mental retardation commonly associated with this condition.

35. (1) Both Statement I and Statement II are correct
Gregor Mendel conducted hybridization experiments on garden pea plants for seven years. He selected seven pairs of contrasting traits, including stem height, flower color and position, pod shape and color, and seed shape and color. Based on his observations, he proposed the fundamental laws of inheritance that describe how discrete units of heredity are passed from parents to their offspring.

36. (3) (A) is correct but (R) is not correct.
The law of independent assortment states that genes for different traits segregate independently during the formation of gametes. However, this rule does not apply to genes located very close together on the same chromosome. Such genes are physically linked and tend to be inherited together as a single unit, which restricts the random shuffling of alleles during the process of meiosis.

37. (4) a, c, b, d
Recombination frequencies represent the relative distances between genes on a chromosome. By analyzing the provided data, we can arrange the genes linearly. The highest frequency between a and d suggests they are furthest apart. Placing c between a and b, and b between c and d, matches all given distances. This method allows for the construction of a consistent chromosomal gene map.

38. (3) Grasshoppers
The XO type of sex determination is a system where the male has only one sex chromosome while the female has two. This pattern is commonly observed in several insect species, most notably grasshoppers. In these organisms, the sex of the offspring is determined by whether the sperm fertilizing the egg carries an X chromosome or lacks a sex chromosome entirely.

39. (2) Myotonic dystrophy
Myotonic dystrophy is an example of a genetic disorder inherited as an autosomal dominant trait. This means that a single copy of the mutated gene, inherited from either parent, is sufficient to cause the disease. This inheritance pattern differs from autosomal recessive conditions like sickle cell anemia and thalassemia, which require two copies of the defective gene for the phenotype to manifest.

40. (4) 100%
A colorblind female is homozygous for the recessive X-linked allele. If she marries a man whose mother was colorblind, the man must also be colorblind because he inherited his only X chromosome from his mother. Since both parents are colorblind, all their offspring, both sons and daughters, will inherit the recessive alleles and express the condition of color blindness.

41. (4) Punnett square
A Punnett square is a graphical representation used to calculate the probability of an offspring having a particular genotype. It was developed by Reginald Punnett to visualize the different combinations of gametes from parents during fertilization. This tool helps in predicting the genotypic and phenotypic ratios of the F_1 and F_2 generations by systematically accounting for all possible zygotic outcomes in a cross.

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than the standard diploid number required for normal development.

23. (4) Both statement I and statement II are false.
Aneuploidy is the gain or loss of individual chromosomes due to non-disjunction during meiosis or mitosis. Polyploidy occurs when a failure of cytokinesis after telophase leads to an increase in a whole set of chromosomes. Both statements provided are incorrect as they swap the definitions of chromosomal loss or gain versus the acquisition of an entire extra set.

24. (3) A-III, B-IV, C-I, D-II
Down's syndrome is caused by trisomy of the twenty-first chromosome. Alpha-thalassemia is linked to genes on the sixteenth chromosome, while beta-thalassemia involves mutations on the eleventh chromosome. Klinefelter's syndrome is a sex chromosomal disorder characterized by an extra X chromosome in males. These associations are critical for understanding the genetic basis of various human inherited diseases and syndromes.

25. (2) 20 produced violet and 20 produced white flowers
A cross between a heterozygous violet plant and a homozygous recessive white plant represents a test cross. The resulting phenotypic ratio is one to one. Out of forty offspring, approximately twenty are expected to show the dominant violet phenotype, while the remaining twenty will express the recessive white trait. This follows the basic Mendelian principles of segregation and dominance.

26. (4) 6
The seed color follows complete dominance, while flower color follows incomplete dominance. Seed color results in two phenotypes, and flower color results in three phenotypes. Under independent assortment, the total number of phenotypic categories in the F_2 generation is the product of the individual ratios. Multiplying two by three yields six distinct phenotypic classes for these two characters combined.

27. (1) (A)-(III), (B)-(IV), (C)-(II), (D)-(I)
A monohybrid cross typically yields a three to one phenotypic ratio in the F_2 generation. A dihybrid cross produces a nine to three to three to one ratio. Incomplete dominance results in a one to two to one ratio where the heterozygote is distinct. A test cross involving a heterozygote and a recessive parent results in a one to one ratio.

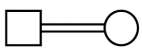
28. (1) Alfred Sturtevant
Alfred Sturtevant, a student of Thomas Hunt Morgan, realized that the frequency of recombination between gene pairs on the same chromosome could be used as a measure of the physical distance between them. He used this principle to construct the first genetic map, showing the relative positions of genes along a chromosome. This pioneered the field of chromosomal mapping.

29. (1) a single gene affecting multiple phenotypic expression
Pleiotropism occurs when a single gene has the ability to influence multiple, seemingly unrelated phenotypic traits. This happens because the gene product may be part of a metabolic pathway used by different tissues or stages of development. A mutation in such a gene can lead to a syndrome of various clinical symptoms across different organ systems in the body.

30. (1) (B) and (D) only
Grasshoppers utilize an XO sex determination system where males have only one X chromosome and females have two. In this mechanism, males are heterogametic because they produce two types of sperms, either with an X chromosome or without any sex chromosome. Conversely, all eggs produced by females contain a single X chromosome. This results in unequal chromosome numbers between sexes.

31. (2) Sickle cell anemia
Sickle cell anemia is caused by a point mutation in the beta-globin gene. Specifically, the substitution of adenine by uracil at the sixth codon of the mRNA (GAG to GUG) changes the amino acid glutamic acid to valine. This single base change alters the hemoglobin structure under low oxygen conditions, causing red blood cells to deform into a sickle shape, which leads to various health complications.

32. (4)



In human pedigree analysis, specific symbols are used to denote familial relationships and clinical status. A horizontal line between a square and a circle represents a standard mating. When two

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1990

225. Both husband and wife have normal vision though their fathers were colour blind. The probability of their daughter becoming colour blind is
(1) 0%
(2) 25%
(3) 50%
(4) 75%

1989

226. Two linked genes a and b show 20% recombination. the individuals of a dihybrid cross between ++/++ × ab/ab shall show gametes
(1) ++ : 80 : : ab : 20
(2) ++ : 50 : : ab : 50
(3) ++ : 40 : : ab : 40 : : + a : 10 : : + b : 10
(4) ++ : 30 : : ab : 30 : : + a : 20 : : + b : 20.

1989

227. A normal green male maize is crossed with albino female. The progeny is albino because
(1) trait for a albinism is dominant
(2) the albinos have biochemical to destroy plastids derived from green male
(3) plastids are inherited from female parent
(4) green plastids of male must have mutated.

1988

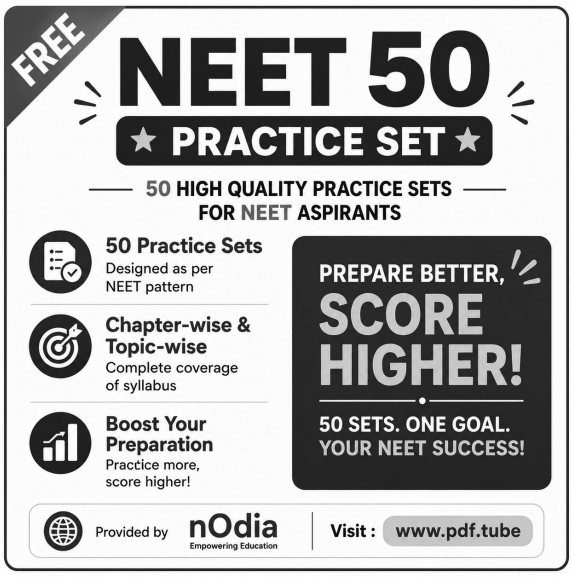
228. Which contribute to the success of Mendel?
(1) Qualitative analysis of data
(2) Observation of distinct inherited traits
(3) His knowledge of biology
(4) Consideration of one character at one time

1988

229. Haploids are able to express both recessive and dominant alleles/mutations because there are
(1) many alleles for each gene
(2) two alleles for each gene
(3) only one allele for each gene in the individual
(4) only one allele in a gene.

1988

230. A family of five daughter only is expecting sixth issue. The chance of its being a son is
(1) zero
(2) 25%
(3) 50%
(4) 100%.



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42. (4) 25%
Sickle cell anemia is an autosomal recessive disorder. When both parents are heterozygous carriers, they each possess one normal allele and one mutated allele. According to Mendelian genetics, their offspring have a twenty-five percent chance of being homozygous recessive and thus diseased. The remaining progeny will be fifty percent carriers and twenty-five percent normal, following the typical one to two to one genotypic ratio.

43. (3) 14
Mendel selected fourteen true-breeding pea plant varieties, which were grouped into seven pairs. Each pair was identical except for one specific character with two contrasting traits. These traits included factors such as stem height, seed shape, seed color, and flower color. By using these stable varieties, Mendel was able to track the inheritance patterns and establish the basic principles of modern genetics.

44. (3) When IA and IB are present together, they express same type of sugar.
The ABO blood group system is controlled by the I gene, which has three alleles. Alleles IA and IB are codominant, meaning that when both are present, they both express their own specific types of sugars on the surface of red blood cells. The statement that they express the same type of sugar is incorrect because they lead to different antigenic structures.

45. (4) Morgan.
While Sutton and Boveri initially proposed the chromosomal theory of inheritance, it was Thomas Hunt Morgan who provided the experimental verification. Working with the fruit fly Drosophila melanogaster, Morgan demonstrated that genes are located on chromosomes. His discovery of sex-linked inheritance provided the first clear evidence that specific genes are physically associated with specific chromosomes during the process of biological inheritance.

46. (3) Sickle cell anaemia - Autosomal recessive trait, chromosome-11
Sickle cell anemia is an autosomal recessive trait caused by a mutation in the beta-globin gene located on chromosome eleven. This mutation involves a single base substitution. Haemophilia is actually an X-linked recessive disorder, and phenylketonuria is an autosomal recessive condition. Thalassemia involves mutations on chromosomes sixteen or eleven, depending on the type, rather than being linked to the X chromosome.

47. (1) Law of segregation does not apply in this experiment.
In Snapdragon, pink flowers result from incomplete dominance, but the law of segregation still applies perfectly. The alleles for red and white flower colors segregate into different gametes during meiosis and then recombine in the F_2 generation. Therefore, claiming that the law of segregation does not apply is incorrect, as the physical separation of alleles remains a fundamental part of the process.

48. (4) A unit of distance between genes on chromosomes, representing 1% cross over.
In genetic mapping, one map unit, also known as a centimorgan, is defined as the distance between two genes that results in a one percent recombination frequency. This unit provides a relative measure of how often crossing over occurs between specific loci on a chromosome. It allows researchers to determine the linear order and relative spacing of genes along the DNA molecule.

49. (4) Alfred Sturtevant.
Alfred Sturtevant was the scientist who first used the frequency of recombination between gene pairs as a measure of the distance between them. He understood that genes located further apart on a chromosome are more likely to undergo crossing over than those located close together. This insight allowed for the creation of genetic maps, which are essential for studying linkage and inheritance.

50. (4) In domesticated fowls, sex of progeny depends on the type of sperm rather than egg.
In domesticated fowls, the sex of the offspring is determined by the female parent, not the male. This is because females are the heterogametic sex, possessing ZW chromosomes, while males are the homogametic sex with ZZ chromosomes. Therefore, eggs can carry either a Z or a W chromosome, which dictates the sex of the progeny upon fertilization by a Z-bearing sperm.

51. (3) Klinefelter's syndrome
Klinefelter's syndrome is a chromosomal disorder in males characterized by the presence of an extra

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where both the A and B antigens are present on the surface of erythrocytes.

70. (1) different molecular forms of a gene
Alleles are defined as different molecular forms of a single gene that occupy the same locus on homologous chromosomes. They govern the same character but may produce different phenotypic effects, such as tall versus dwarf height in pea plants. The interaction between different alleles determines the specific genotype and phenotype of an individual organism for a given trait in Mendelian and non-Mendelian inheritance.

71. (1) at the same locus of the chromosome
Multiple alleles refer to a situation where more than two alternative forms of a gene exist within a population. Despite the variety of alleles available, any individual diploid organism can only possess two alleles. These multiple alleles are always located at the same locus on homologous chromosomes. This is why they are considered variations of the same gene rather than being different genes altogether.

72. (1) A, B, AB and O
If a man with blood group A is heterozygous and a woman with blood group B is also heterozygous, they can produce children with any of the four major blood groups. Their offspring could inherit combinations resulting in blood groups A, B, AB, or O. This occurs because both parents carry the recessive i allele, which can pair to form the O phenotype.

73. (3) T.H. Morgan
The term linkage was coined by Thomas Hunt Morgan. Through his extensive research on Drosophila melanogaster, Morgan observed that certain genes did not assort independently as predicted by Mendelian laws because they were physically located on the same chromosome. His work laid the foundation for understanding how chromosomal proximity affects the inheritance of multiple traits and led to the development of early genetic maps.

74. (1) translocation
Translocation is the chromosomal process where a gene or a segment of DNA moves from one linkage group to another non-homologous chromosome. This structural rearrangement can occur reciprocally or non-reciprocally. Unlike crossing over, which swaps segments between homologous chromosomes, translocation involves different chromosome pairs. It is a significant source of genetic variation and can sometimes lead to reproductive challenges or genetic disorders in offspring.

75. (2) controls multiple traits in an individual
A pleiotropic gene is a single gene that controls or influences multiple, often unrelated phenotypic traits in an individual. This happens because the protein encoded by the gene may function in various biological pathways or tissues. A classic example is phenylketonuria in humans, where a single metabolic defect leads to multiple symptoms, including mental retardation and changes in skin and hair pigmentation.

NODIA

76. (2) 0.25
A color-blind man and a normal woman will produce daughters who are carriers. When a carrier daughter marries a normal man, her sons have a fifty percent chance of being color-blind. Since half the grandsons are from daughters and half from sons, and only the daughters' sons can be affected, the overall probability of a grandson being color-blind is twenty-five percent in this scenario.

77. (1) Autosomal recessive
An autosomal recessive trait is characterized by affected individuals born to unaffected parents who are heterozygous carriers. This pattern often shows the trait skipping generations and affects both males and females with equal frequency. In the provided pedigree, the appearance of the disease in offspring of healthy parents strongly suggests a recessive mode of inheritance where both parents contribute a hidden defective allele.

78. (4) formation of abnormal ova in the mother.
An abnormal human baby with XXX sex chromosomes typically results from the formation of abnormal ova in the mother due to non-disjunction during meiosis. If the two X chromosomes fail to separate, an egg with two X chromosomes is produced. Fertilization of this abnormal egg by a normal X-bearing sperm results in a zygote with three X chromosomes, causing the Triple X syndrome.

79. (2) dominant epistasis
Fruit color in summer squash is a classic example of dominant epistasis. In this genetic interaction, a dominant allele at one locus masks

one homozygous dwarf plant. This ratio reflects the segregation and random recombination of parental alleles.

61. (3) translocation
Translocation is a chromosomal mutation where a segment of one chromosome breaks off and attaches to a non-homologous chromosome. This process effectively moves genes from one linkage group to another. Unlike crossing over, which occurs between homologous chromosomes, translocation involves structural changes between different chromosome pairs. It can lead to significant genetic rearrangements and may cause various disorders or affect the fertility of individuals.

62. (1) the two genes are linked and present on the same chromosome
In a dihybrid test cross, if the number of parental-type offspring is significantly higher than the recombinant-type offspring, it indicates that the two genes are linked. This physical association means the genes are located close together on the same chromosome and do not assort independently. The frequency of recombinants depends on the distance between these linked genes and the occurrence of crossing over.

63. (4) (ii) (iii) (iv) (i)
Dominance describes a scenario where only one allele expresses itself in a heterozygote. Co-dominance occurs when both alleles are fully expressed. Pleiotropy refers to a single gene influencing multiple traits, such as in phenylketonuria. Polygenic inheritance involves many genes governing a single phenotypic character, like human skin color. These terms describe the diverse ways that alleles and genes interact to produce observable traits.

64. (1) 0
Color blindness is an X-linked recessive disorder. A color-blind man has the genotype XcY and passes his Xc chromosome only to his daughters, who will be carriers. His sons receive his Y chromosome and their mother's normal X chromosome. Therefore, all sons will have normal color vision, making the probability of a son being color-blind zero in this specific genetic cross.

65. (2) (A), (B) and (C) are correct.
Haemophilia is indeed a sex-linked recessive disease, and Down's syndrome is caused by aneuploidy, specifically trisomy twenty-one. Phenylketonuria is also correctly identified as an autosomal recessive gene disorder. However, sickle cell anemia is an autosomal recessive disorder, not an X-linked one. Therefore, the statements regarding haemophilia, Down's syndrome, and phenylketonuria are all accurate within the context of basic human medical genetics.

66. (4) X-linked recessive gene disorder
Haemophilia is most appropriately described as an X-linked recessive gene disorder. This means the defective gene is located on the X chromosome and the condition primarily affects males because they possess only one X chromosome. Females are typically carriers and only express the disease if they inherit two copies of the recessive allele. It is characterized by the body's inability to form blood clots properly.

67. (4) pod length.
Mendel examined seven specific characters in the garden pea: seed shape, seed color, flower color, pod shape, pod color, flower position, and stem height. While he considered pod shape, he did not use pod length as one of his contrasting traits. His careful selection of these seven discrete traits allowed him to identify clear mathematical patterns and formulate the laws of modern genetics.

68. (2) Seven
Gregor Mendel studied seven pairs of contrasting characters in pea plants during his hybridization experiments. These traits included height, seed shape and color, flower color and position, and pod shape and color. By focusing on these seven distinct pairs, Mendel was able to deduce the fundamental principles of inheritance, which laid the groundwork for the entire field of genetics in the years following.

69. (2) both alleles independently expressed in the heterozygote
A gene showing co-dominance has alleles that are both independently and fully expressed in the heterozygous condition. This results in a phenotype that displays the characteristics of both alleles simultaneously, rather than a blend or a dominant-recessive relationship. A classic example is the AB blood group in humans,

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126. (3) this disease is due to an X-linked recessive mutation
Haemophilia is more commonly observed in males because it is caused by an X-linked recessive mutation. Since males have only one X chromosome, a single copy of the defective gene results in the disease. Females, however, have two X chromosomes and would need to inherit two copies of the mutant allele to express the disorder, which is a much less frequent genetic event.

127. (4) Cretinism
Cretinism is not a hereditary disease in the sense of being caused by a specific gene mutation passed from parents. Instead, it is a condition of severely stunted physical and mental growth due to untreated congenital deficiency of thyroid hormones, often related to maternal iodine deficiency during pregnancy. In contrast, cystic fibrosis, thalassemia, and haemophilia are all classic examples of inherited genetic disorders.

128. (1) may be colour blind or may be of normal vision
A woman with normal vision whose father was color-blind must be a carrier, as she inherited one defective X chromosome. If she marries a color-blind man, their sons will receive either her normal X or her mutant X chromosome. Therefore, any son they have has a fifty percent chance of being color-blind and a fifty percent chance of having normal vision.

129. (2) 50% will be tall with red fruit
In a cross between RRTt and rrtt, the RRTt parent produces gametes RT and Rt, while the rrtt parent produces only rt gametes. The resulting offspring genotypes are RrTt and Rrtt in equal proportions. Since red fruit and tallness are dominant, RrTt plants will be tall with red fruit, while Rrtt plants will be short with red fruit. Thus, fifty percent.

130. (3) linkage
The lack of independent assortment between two genes in Drosophila is primarily due to linkage. This occurs when genes are located on the same chromosome and are physically close to each other. Such genes tend to be inherited together as a single unit rather than segregating independently during gamete formation. Linkage reduces the frequency of recombination and deviates from expected Mendelian dihybrid ratios.

131. (2) none of the progenies
Mitochondrial DNA is inherited almost exclusively from the mother through the cytoplasm of the egg. The sperm contributes very little to no cytoplasm to the zygote during fertilization. Therefore, if a male parent has a mutation in its mitochondria, that mutation will not be passed on to the offspring. Consequently, none of the F_2 progenies will exhibit the mitochondrial mutation in this cross.

132. (4) 1/8
The male is heterozygous for two autosomal genes (Aa, Bb) and carries the haemophilia gene on his X chromosome. To produce an abh sperm, he must contribute the recessive a, the recessive b, and the X chromosome carrying the haemophilia allele. The probability of each allele segregating is one-half. Multiplying these independent probabilities (one-half times one-half times one-half) yields a final proportion of one-eighth.

133. (2) 50% colour-blind
A normal woman whose father was color-blind is a heterozygous carrier of the X-linked recessive allele. Her husband has a normal X chromosome. When they have sons, each son has a fifty percent chance of inheriting the defective X chromosome from his mother and being color-blind. The other fifty percent will inherit the normal X chromosome and have normal color vision.

134. (3) expressed in males
Recessive genes located on the X chromosome are always expressed in males because they possess only one X chromosome. This condition is known as hemizygosity. In contrast, females have two X chromosomes and will only express the recessive trait if they inherit two copies of the allele. This explains why X-linked recessive disorders like color blindness and haemophilia are more prevalent in the male population.

135. (2) Green seed colour
Among the traits studied by Mendel in pea plants, green seed color is a recessive feature. In contrast, yellow seed color is dominant. Other dominant traits include axial flower position, green pod color, and round seed shape. Mendel's focus on these specific contrasting pairs allowed

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the phenotypic expression of alleles at a second locus. For instance, the presence of a dominant white allele prevents the expression of yellow or green colors, regardless of the genotype at the other locus, resulting in a twelve to three to one ratio.

80. (3) 50%
The man has normal vision since his father's color blindness cannot be passed to him. The woman is a carrier because her mother was color-blind. When a normal man and a carrier woman have children, their sons have a fifty percent chance of inheriting the defective X chromosome and being color-blind. This is because sons receive their only X chromosome from their mother.

81. (1) has 45 chromosomes with XO
A human female with Turner's syndrome possesses forty-five chromosomes with an XO genotype, meaning she lacks one X chromosome. This condition results from chromosomal non-disjunction during gamete formation. Affected individuals are typically sterile, have short stature, and may lack secondary sexual characteristics. They do not exhibit male characters but rather have underdeveloped female reproductive systems due to the missing sex chromosome genetic information.

82. (3) codominance
The presence of both A and B proteins in individuals with the AB blood group is a definitive example of codominance. In this genetic relationship, both alleles IA and IB are fully expressed in the phenotype of the heterozygote. Neither allele is dominant over the other, and there is no blending. Instead, both gene products are independently produced and detectable on the cell surface.

83. (2) Co-dominance
Codominance is the genetic phenomenon where the F_1 generation expresses the phenotypic traits of both parents simultaneously. Unlike incomplete dominance, where an intermediate phenotype is formed, or complete dominance, where only one parental trait is seen, codominance allows both alleles to function fully. The human AB blood group is the most common example, where both A and B antigens are present together.

84. (4) The genes are tightly linked.
A recombination frequency of fifty percent indicates that genes are either located on different chromosomes or are very far apart on the same chromosome. In both cases, they exhibit independent assortment. However, fifty percent recombination is the maximum possible value and is the opposite of tight linkage. Tightly linked genes stay together during meiosis and show very low recombination frequencies, often close to zero percent.

85. (1) It is a dominant disease.
Haemophilia is an X-linked recessive disorder, not a dominant one. It is characterized by the deficiency of a specific protein factor essential for blood clotting. Because it is sex-linked and recessive, it more frequently affects males, while females are usually asymptomatic carriers. A single defective gene on the X chromosome is enough to cause the disease in males, who have only one X chromosome.

86. (1) 25%
Thalassemia is an autosomal recessive disorder. If both parents are heterozygous carriers, they each have one normal and one mutant allele. According to Mendelian principles, there is a twenty-five percent probability that an offspring will inherit two mutant alleles and be affected by the disease. There is also a fifty percent chance for carrier status and a twenty-five percent chance for being completely normal.

87. (1) It confirms that DNA is the carrier of genetic information.
Pedigree analysis is a powerful tool for tracing the inheritance of specific traits through generations and determining whether they are dominant, recessive, or sex-linked. However, it cannot confirm that DNA is the carrier of genetic information. That fact was established through molecular biology experiments by scientists like Avery, McLeod, McCarty, and Hershey-Chase, rather than through the study of family history charts and phenotypes.

88. (2) three copies of chromosome 21
Down's syndrome in humans is caused by the presence of three copies of chromosome twenty-one instead of the usual pair. This condition, known as trisomy twenty-one, typically arises from chromosomal non-disjunction during the formation of gametes in one of the parents. The

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107. (2) caused by a change in a single base pair of DNA
Sickle-cell anemia is caused by a point mutation involving a change in a single base pair of DNA. Specifically, the conversion of GAG to GUG in the messenger RNA results in the replacement of glutamic acid by valine at the sixth position of the beta-globin chain. This molecular change causes the hemoglobin to polymerize, distorting red blood cells into a sickle shape.

108. (1) Inheritance of a condition like phenylketonuria as an autosomal recessive trait.
The pedigree chart shows affected individuals born to unaffected parents, which is the hallmark of an autosomal recessive inheritance pattern. Phenylketonuria is a classic example of such a trait. In this pattern, the trait can skip generations, and both males and females are affected with equal probability. Heterozygous parents who appear normal can pass the recessive alleles to their offspring during fertilization.

109. (3) Klinefelter's syndrome - 44 autosomes + XXY
Klinefelter's syndrome is correctly matched with the chromosomal abnormality of forty-four autosomes plus XXY. This results in a total of forty-seven chromosomes. Down's syndrome is caused by trisomy twenty-one, not XO. Colour blindness is an X-linked recessive trait, not Y-linked. Erythroblastosis fetalis is an immunological condition related to Rh factor incompatibility between mother and fetus, rather than being a simple X-linked disorder.

110. (4) 50 : 50
Crossing a heterozygous yellow seeded plant (Yy) with a green seeded plant (yy) is a test cross. According to Mendelian segregation, the gametes will combine to produce offspring in a fifty-fifty ratio. Specifically, half of the plants will be heterozygous yellow (Yy) and the other half will be homozygous recessive green (yy). This results in an equal distribution of the two phenotypes.

111. (3) crossing of one F_1 progeny with male parent
A common method to find the genotype of an F_1 hybrid is the test cross, which involves crossing the hybrid with the homozygous recessive parent. This reveals whether the hybrid is homozygous or heterozygous for the traits being studied. If any recessive phenotypes appear in the offspring, the hybrid must carry the recessive allele. This technique is fundamental for genetic research and breeding.

112. (4) AaBb
A male producing four types of gametes (AB, Ab, aB, and ab) in equal proportions must be heterozygous for both genes. This is because the law of independent assortment states that alleles of different genes segregate independently during meiosis. A genotype of AaBb allows for these four combinations. Homozygous genotypes would produce fewer types of gametes, and linkage would alter the equal proportions.

113. (2) polygenic inheritance
The inheritance of skin color in humans is a classic example of polygenic inheritance. This trait is controlled by multiple genes, each contributing a small, additive effect to the final phenotype. The interaction of these many alleles results in a continuous spectrum of skin tones rather than discrete categories. This complexity explains why there is such significant variation in pigmentation across human populations.

114. (4) crossing the F_1 hybrid with a double recessive genotype.
A test cross involves crossing an F_1 hybrid with a double recessive genotype. This procedure is used to determine the zygosity of the hybrid for specific traits. By using a homozygous recessive parent, the phenotypic ratios of the offspring directly reflect the gametic output of the hybrid. This allows geneticists to confirm Mendelian inheritance patterns and identify potential linkage between the genes being studied.

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115. (1) genotype and environment interactions
The phenotype of an organism is the observable physical and physiological expression of its genetic makeup. It results from the complex interaction between the individual's genetic code and the surrounding environment. While genes provide the blueprint for development, environmental factors such as nutrition, light, and temperature can significantly influence how those genes are expressed, leading to the final outward appearance and internal functioning.

116. (1) Round seeds with yellow cotyledons, and wrinkled seeds with yellow cotyledons
Crossing RRYY and rryy results in an F_1 generation that is entirely RrYy. In the F_2

98. (1) test cross
To determine whether an individual showing a dominant phenotype is homozygous or heterozygous, a test cross is used. This involves crossing the individual with a homozygous recessive partner. If all offspring show the dominant trait, the parent is homozygous. If half show the recessive trait, the parent is heterozygous. This simple breeding test is a fundamental tool in classical Mendelian genetic analysis.

99. (3) Alleles do not show any blending and both the characters recover as such in F_2 generation.
Mendel's law of dominance explains that factors occur in pairs and one can mask the other. However, the fact that alleles do not show any blending and both characters are recovered in the F_2 generation is explained by the law of segregation. This law states that alleles separate during gamete formation, ensuring that the traits remain distinct and can reappear in later generations.

100. (3) Four
In the ABO blood grouping system, three alleles interact to produce six different genotypes. However, due to the relationships of dominance and codominance among these alleles, only four phenotypes are expressed in the population. These phenotypes are blood group A, blood group B, blood group AB, and blood group O. This demonstrates how molecular variation at a single locus produces discrete biological categories.

101. (3) test cross
A test cross is a specific type of genetic cross where an organism expressing a dominant phenotype is mated with a homozygous recessive individual. The purpose of this cross is to determine the genotype of the dominant organism. If any recessive offspring are produced, the dominant parent must be heterozygous; otherwise, it is likely homozygous. This method is essential for verifying genetic purity.

102. (3) Rr
In Antirrhinum, flower color shows incomplete dominance. A cross between two pink-flowered plants, which are both heterozygous Rr, results in an F_2 generation with a ratio of one red (RR) to two pink (Rr) to one white (rr). This occurs because the R allele is not completely dominant over the r allele, leading to an intermediate phenotype in the heterozygous condition during development.

103. (4) Tightly linked genes on the same chromosome show very few recombinations.
Genes that are located very close to each other on the same chromosome are said to be tightly linked. Such genes tend to be inherited together and show very few recombinations during meiosis because the chance of a crossover occurring between them is low. Conversely, genes that are far apart or on different chromosomes show higher frequencies of recombination due to independent assortment.

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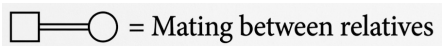
104. (1)



In human pedigree analysis, a horizontal line connecting a square and a circle represents mating. Two parallel horizontal lines specifically indicate a consanguineous mating, which is a mating between close relatives. Other symbols include squares for males and circles for females, with filled symbols representing affected individuals and open symbols representing those who are unaffected. These standardized symbols allow for clear genealogical mapping.

105. (1) The female parent is heterozygous.
In the provided pedigree chart, the appearance of an affected daughter from unaffected parents indicates a recessive trait. If the trait were X-linked, an affected daughter would require an affected father. Since the father is normal, the trait must be autosomal recessive. For this to occur, both parents must be heterozygous carriers, possessing one normal and one defective allele for the specific character.

106. (3) Baldness is a sex-limited trait.
Baldness is actually a sex-influenced trait, not a sex-limited trait. Sex-influenced traits are expressed differently in males and females due to hormonal levels, even if the genotype is the same. Sex-limited traits, however, are only expressed in one sex. The other statements regarding galactosemia, genetic drift in small populations, and linkage being an exception to independent assortment are all factually correct biological principles.

X chromosome, resulting in a forty-seven, XXY karyotype. Affected individuals typically show masculine development but also possess feminine features like breast development, known as gynecomastia. They are usually sterile and may exhibit other physical and cognitive symptoms due to the imbalance of sex chromosome gene products.

52. (2) (i), (ii) and (iii)
The inheritance of ABO blood groups in humans demonstrates dominance, co-dominance, and multiple allelism. The I gene has three alleles, where IA and IB are both dominant over the recessive i allele. Furthermore, IA and IB show co-dominance when they are present together in an individual. However, this system does not typically involve incomplete dominance or polygenic inheritance in its standard form.

53. (1) Starch synthesis in pea : Multiple alleles
Starch synthesis in pea seeds is an example of pleiotropy and incomplete dominance rather than multiple allelism. The size of starch grains depends on the dosage of alleles, showing a range of sizes in heterozygous individuals. Meanwhile, ABO blood grouping is a well-known example of co-dominance, and the XO sex determination system is found in grasshoppers, as correctly described in other associations.

54. (4) both sons and daughters.
A woman possesses two X chromosomes and transmits one to each of her children, regardless of their sex. Therefore, an X-linked condition present on one of her chromosomes can be inherited by both her sons and her daughters. Sons receive their only X chromosome from their mother, while daughters receive one X from each parent, making them potential carriers or affected individuals.

55. (1) Trichomes-Glandular or non-glandular
Mendel studied seven specific characters in pea plants: stem height, flower color, flower position, pod shape, pod color, seed shape, and seed color. Trichomes, whether glandular or non-glandular, were not among the traits he investigated. His success was largely due to his focus on these discrete, easily observable traits that followed clear patterns of inheritance across successive generations of his experiments.

56. (4) 1856-1863
Gregor Mendel conducted his famous hybridization experiments on garden peas over a period of seven years, from eighteen fifty-six to eighteen sixty-three. During this time, he meticulously tracked the inheritance of specific traits through thousands of plants. His findings were published in eighteen sixty-five, though their significance was not fully recognized until the rediscovery of his work by other scientists later on.

57. (2) 4 genotypes; 3 phenotypes
Crossing parents with genotypes IAIB and IAi produces four possible offspring genotypes: IAIA, IAi, IAIB, and IBi. These genotypes correspond to three distinct blood group phenotypes: type A, type AB, and type B. This variety occurs because the A and B alleles are codominant with each other while both remain dominant over the recessive i allele in the ABO blood group system.

58. (2) Thalassemia is due to less synthesis of globin molecules.
Thalassemia and sickle cell anemia are both globin-related disorders but differ in nature. Thalassemia is a quantitative disorder where the rate of synthesis of one of the globin chains is reduced. In contrast, sickle cell anemia is a qualitative disorder caused by a structural change in the hemoglobin molecule due to a single amino acid substitution. This distinction is fundamental to their pathology.

59. (4) Down's syndrome.
Down's syndrome is caused by the non-disjunction of the twenty-first pair of autosomes during gamete formation. This error results in a zygote with an extra copy of this chromosome, a condition known as trisomy twenty-one. While Klinefelter's and Turner's syndromes also involve non-disjunction, they affect the sex chromosomes rather than autosomes. Sickle cell anemia is a point mutation, not a chromosomal number disorder.

60. (3) 1 : 2 : 1 : : Tall homozygous : Tall heterozygous : Dwarf
When a true-breeding tall plant is crossed with a true-breeding dwarf plant, the F_1 generation is entirely heterozygous tall. Selfing the F_1 results in a genotypic ratio of one to two to one in the F_2 generation. This represents one homozygous tall plant, two heterozygous tall plants, and

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generation, independent assortment of the two gene pairs leads to four different phenotypes in a nine to three to three to one ratio. These include round yellow, round green, wrinkled yellow, and wrinkled green seeds. All these combinations occur due to the random segregation of alleles.

117. (1) Two
The number of different types of gametes produced by an organism can be calculated using the formula two to the power of n, where n is the number of heterozygous gene pairs. In the genotype AABbCC, only one gene pair (Bb) is heterozygous. Therefore, two to the power of one equals two. The plant will produce two types of gametes: ABC and AbC.

118. (1) Skin colour in humans
Skin color in humans is an example of polygenic inheritance, where a single trait is controlled by the collective effect of several genes. Each gene has a small additive influence, resulting in continuous variation of the phenotype within the population. Other examples provided, like flower color in Mirabilis or pod shape in peas, follow simpler Mendelian patterns or incomplete dominance rather than polygenic control.

119. (3) congenital disorders
Both sickle cell anemia and Huntington's chorea are examples of congenital disorders, meaning they are present from birth and result from genetic mutations. Sickle cell anemia is an autosomal recessive condition affecting hemoglobin, while Huntington's chorea is an autosomal dominant neurodegenerative disorder. These diseases are inherited from parents through defective alleles and are not caused by external environmental pollutants or infectious pathogens.

120. (1) all colour blind
Color blindness is an X-linked recessive trait. A color-blind woman is homozygous for the recessive allele and will pass one defective X chromosome to all of her sons. Since sons receive their only X chromosome from their mother and a Y chromosome from their father, they will all inherit the mutation. Consequently, every son born to this couple will be color blind.

121. (3) loss of half of the short arm of chromosome 5
Cri-du-chat syndrome is a rare genetic disorder in humans caused by a structural chromosomal abnormality. Specifically, it results from the deletion or loss of a significant portion of the short arm of chromosome five. The name refers to the characteristic cat-like cry of affected infants, which is due to problems with the larynx and nervous system caused by the missing genetic material.

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122. (4) it provides immunity against malaria.
Sickle cell anemia has persisted in African populations because individuals who are heterozygous for the trait possess a selective advantage. These carriers are more resistant to malaria, a deadly disease prevalent in those regions. This phenomenon, known as heterozygote advantage, ensures that the recessive allele remains in the gene pool despite the severe health consequences for individuals who are homozygous for the mutation.

123. (3) aabb
To identify the different types of gametes produced by a dihybrid plant with the genotype AaBb, it should be crossed with a plant that is homozygous recessive for both traits, which is aabb. This test cross allows the phenotypic ratio of the offspring to directly represent the frequency of gametes produced by the parent, confirming independent assortment or detecting potential linkage.

124. (2) Sex-linked recessive
When a disease appears in sons but not in daughters of unaffected parents, it strongly suggests a sex-linked recessive inheritance pattern. In this scenario, the mother is a heterozygous carrier of the defective gene on one of her X chromosomes. She passes the mutant allele to half of her sons, who express the disease because they have only one X chromosome.

125. (4) Down's syndrome.
A human female with forty-seven chromosomes due to the presence of three copies of chromosome twenty-one is characterized by Down's syndrome. This condition is also known as trisomy twenty-one. It results from chromosomal non-disjunction during meiosis. Affected individuals typically exhibit mental retardation, a flattened facial profile, and other distinct physical characteristics. It is the most common chromosomal disorder in the human population.

extra genetic material leads to characteristic physical features, developmental delays, and various health issues that define this well-known chromosomal disorder.

89. (4) monohybrid cross with incomplete dominance.
When the genotypic and phenotypic ratios in the F_2 generation are both one to two to one, it indicates incomplete dominance. In this case, the heterozygous individual has a phenotype that is intermediate between the two homozygous parents. A classic example is flower color in Mirabilis jalapa or Snapdragon, where crossing red and white flowers produces pink offspring in the F_1 generation.

90. (1) determine the genotype of a plant at F_2
A test cross is performed to determine the unknown genotype of an individual expressing a dominant phenotype. By crossing this individual with a homozygous recessive parent, the offspring's phenotypes reveal whether the tested plant is homozygous or heterozygous. This technique is a fundamental tool in classical genetics for identifying the genetic makeup of organisms based on their breeding patterns and progeny results.

91. (2) Zero percent
A normal-visioned man has a normal X chromosome. A woman whose father was color-blind is a carrier, having one normal and one defective X chromosome. Any daughter born to this couple will receive the father's normal X chromosome. Since color blindness is an X-linked recessive trait, a daughter must have two defective alleles to be color-blind. Therefore, the chance is zero percent.

92. (3) Haemophilia
The diagram represents criss-cross inheritance, which is characteristic of X-linked recessive traits. In this pattern, a trait is transmitted from an affected father to his grandsons through his carrier daughters. Haemophilia is a well-known example of such an X-linked recessive disorder in humans. Other conditions like sickle cell anemia and phenylketonuria follow autosomal inheritance patterns and do not show this specific sex-linked trend.

93. (3) the F_1 hybrid with a double recessive genotype
A test cross involves crossing an F_1 hybrid or an individual with an unknown genotype expressing a dominant trait with a double recessive genotype. This specific mating reveals whether the dominant parent is homozygous or heterozygous for the genes being studied. If the parent is heterozygous, the offspring will show a one to one ratio for each trait, following standard Mendelian segregation rules.

94. (1) heterosis
Heterosis, also known as hybrid vigor, is the phenomenon where the F_1 hybrid produced by crossing two unrelated individuals or lines exhibits superior performance compared to both parents. This increased fitness can manifest as faster growth, higher yield, or better resistance to diseases. It is widely used in agriculture to improve crop productivity and is the result of increased heterozygosity in the offspring.

95. (1) Two X chromosomes
The birth of a normal human female child requires a zygote to have two X chromosomes, one inherited from each parent. The sex of a human is determined by the sex chromosomes present at the time of fertilization. An XX combination results in a female, while an XY combination leads to a male. This chromosomal mechanism ensures an approximately equal ratio of sexes.

96. (2) XO type of sex chromosomes determine male sex in grasshopper.
In grasshoppers, sex is determined by the XO system, where the presence of a single X chromosome results in a male and two X chromosomes result in a female. Therefore, the XO condition correctly identifies a male grasshopper. Other systems include the ZW system in birds where ZZ is male, and the XY system in humans and Drosophila where XX is usually female.

97. (3) Four
Although there are six possible genotypes in the ABO blood group system due to three alleles, only four distinct phenotypes occur. These are blood groups A, B, AB, and O. Phenotypes A and B can result from both homozygous and heterozygous genotypes, while AB and O only come from specific combinations. This is a classic example of multiple allelism and codominance in humans.

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him to identify clear inheritance patterns that form the basis of the laws of dominance and segregation.

136. (4) Four
The genes controlling the seven characters studied by Mendel in the garden pea are located on four different chromosomes. Specifically, they are found on chromosomes one, four, five, and seven. Although pea plants have seven pairs of chromosomes, Mendel's chosen traits were not distributed one per chromosome. Some traits showed independent assortment because the genes were located far apart on the same chromosome.

137. (2) reciprocal cross
A reciprocal cross involves two separate matings where the genotypes of the male and female parents are reversed between the crosses. This technique is used to determine if the sex of the parent carrying a particular trait influences its inheritance pattern. It is especially useful for identifying sex-linked traits or traits inherited through organelle DNA, such as mitochondrial or chloroplast genes in eukaryotes.

138. (1) the ratio of number of X-chromosome to the sets of autosomes
In Drosophila, sex is determined by the genic balance system, which is the ratio of the number of X chromosomes to the number of sets of autosomes. A ratio of one leads to a female, while a ratio of zero point five results in a male. Although the Y chromosome is present in males, it is required for fertility rather than sex determination.

139. (3) sex influenced traits
Pattern baldness and the development of a beard or mustache are examples of sex-influenced traits in humans. These traits are controlled by genes located on autosomes, but their expression is influenced by the hormonal environment of the individual. For instance, the same genotype may lead to baldness in males due to high testosterone levels but not in females who have different hormonal profiles.

140. (2) Sickle cell anaemia
Sickle cell anemia is a genetic disorder that, while harmful, provides protection against malaria, a serious mosquito-borne disease. Individuals who carry a single copy of the sickle cell gene exhibit a selective advantage in regions where malaria is endemic. This occurs because the malaria parasite cannot survive and multiply effectively within the unusually shaped red blood cells of these heterozygous carrier individuals.

141. (3) 50%
Down's syndrome is caused by trisomy twenty-one. If an affected mother has three copies of chromosome twenty-one, her gametes will receive either one or two copies of this chromosome during meiosis. A gamete with two copies, when fertilized by a normal sperm with one copy, results in an affected child. Theoretically, fifty percent of her offspring would inherit the extra chromosome and be affected.

142. (1) haemophilia B
Christmas disease is another name for haemophilia B, which is a blood clotting disorder caused by a deficiency of factor nine. It is named after Stephen Christmas, the first patient described with this specific condition. Like haemophilia A, it is an X-linked recessive disorder that primarily affects males. It results in prolonged bleeding after injury and can lead to serious internal bleeding complications.

143. (3) it expresses its effect both in homozygous and heterozygous condition
A gene is considered dominant if it expresses its phenotypic effect in both homozygous and heterozygous conditions. This means that only one copy of the dominant allele is required for the trait to be observable. In a heterozygous state, the dominant allele masks the presence of the recessive allele. This principle is a cornerstone of Mendelian genetics and explains the inheritance of many traits.

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144. (1) b, a, c
To determine the sequence of genes on a chromosome, one must look at the recombination frequencies. The largest distance is between b and c (twenty-eight percent). The distance between a and b is twenty percent, and between a and c is eight percent. Adding twenty and eight gives twenty-eight. Therefore, gene a must be located between b and c, making the sequence b-a-c.

145. (1) 3 : 1
Selfing a plant with the genotype AABbCC involves only the heterozygous gene pair Bb, as the other genes are homozygous. This effectively

behaves like a monohybrid cross. The resulting genotypic ratio in the F_2 generation will follow the standard Mendelian pattern of one to two to one, or a phenotypic ratio of three to one, depending on the dominance relationship of the alleles.

146. (3) Sickle cell anaemia
Sickle cell anemia is an example of pleiotropy because a single genetic mutation in the beta-globin gene affects multiple organ systems. The primary effect is the distortion of red blood cells, which then leads to a cascade of secondary effects, including anemia, organ damage, and pain crises. This demonstrates how one gene can have diverse and widespread phenotypic consequences throughout the entire body.

147. (1) sex linked dominant
When a diseased father passes a trait to all of his daughters but none of his sons, the inheritance pattern is sex-linked dominant. The father passes his only X chromosome, which carries the dominant disease allele, to every daughter. Since sons receive only the Y chromosome from their father and a normal X chromosome from their mother, they remain unaffected by the disease.

148. (1) Down's syndrome - 21st chromosome
Down's syndrome is correctly matched with the twenty-first chromosome, as it is caused by the trisomy of this specific autosome. Sickle cell anemia is an autosomal recessive disorder linked to chromosome eleven. Haemophilia is an X-linked recessive disorder, not Y-linked. Parkinson's disease is a complex neurological condition that is not simply linked to a single sex chromosome in a standard Mendelian fashion.

149. (1) co-dominance
When both alleles of a gene express themselves simultaneously in a heterozygote, the phenomenon is called co-dominance. This results in a phenotype where both traits are clearly visible and independent. A standard example is the human AB blood group, where both A and B antigens are produced. This differs from incomplete dominance, where an intermediate blended phenotype is observed.

150. (4) complementary gene.
When two non-allelic genes interact to produce a new phenotype only when present together, they are known as complementary genes. Individually, neither gene can produce the specific trait. This type of gene interaction deviates from standard Mendelian ratios. A classic example is flower color in sweet peas, where two separate enzymes are required to synthesize the final pigment, requiring both dominant genes.

151. (2) AaBb and aabb
In a cross between a dihybrid with linked genes in the cis configuration (AB/ab) and a double recessive parent (ab/ab), the parental genotypes in the offspring will be AaBb and aabb. Linkage means that the AB and ab allele combinations tend to stay together. Therefore, these two genotypes will be produced in much higher frequencies compared to any recombinant types formed.

152. (4) 9 : 7.
The phenotypic ratio for complementary gene interaction in the F_2 generation is nine to seven. This occurs because the dominant alleles of two different genes must be present together to express a particular trait. Any other combination, such as having only one dominant gene or being homozygous recessive for both, results in the alternative phenotype. This is a modification of the dihybrid ratio.

153. (2) genes are linked and located on same chromosome
Independent assortment of genes does not occur when the genes are linked and located on the same chromosome. Such genes are physically tied together and tend to be inherited as a single unit during meiosis. The frequency of their separation depends on the physical distance between them and the likelihood of crossing over. This physical proximity overrides the random distribution of alleles.

154. (3) 3
The number of Barr bodies in a cell is determined by the formula n minus one, where n is the total number of X chromosomes. In an XXXX female, there are four X chromosomes. Applying the formula, four minus one equals three. Therefore, three Barr bodies will be present, as all X chromosomes except for one are inactivated to maintain dosage compensation.

155. (2) transfer of segments in X and Y chromosome
Male XX and female XY individuals can sometimes occur due to the transfer of

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chromosome segments between the X and Y chromosomes during meiosis. Specifically, if the SRY gene, which is responsible for male sex determination, is translocated from the Y to the X chromosome, an XX individual can develop as a male. Conversely, an XY individual lacking the SRY gene develops as female.

156. (3) 1/16
The probability of having a son or a daughter is one-half for each birth. Since each birth is an independent event, the probability of having four sons in a row is calculated by multiplying the individual probabilities together. One-half multiplied by itself four times equals one-sixteenth. This mathematical calculation demonstrates the likelihood of specific gender sequences in a family of four children.

157. (2) change of amino acid in β-chain of haemoglobin
Sickle cell anemia is caused by a specific change in the amino acid sequence of the beta-globin chain of hemoglobin. A point mutation in the DNA results in the substitution of valine for glutamic acid at the sixth position of this chain. This single alteration changes the physical properties of the hemoglobin molecule, causing it to crystallize and deform red blood cells.

158. (4) Green pod colour
According to Mendel's experiments on garden peas, green pod color is a dominant character. In his studies, he observed that several other traits were also dominant, such as round seeds, yellow seeds, and axial flower position. Understanding which traits are dominant and which are recessive was essential for Mendel to formulate his laws of inheritance and predict the outcomes of genetic crosses.

159. (1) 50%
In a cross between TTRr and ttrr, the TTRr parent produces gametes TR and Tr, while the ttrr parent produces only tr gametes. The offspring genotypes will be TtRr and Ttrr in equal proportions. Since tallness and red flower color are both dominant, the TtRr plants will be tall and red-flowered. Therefore, fifty percent of the progeny will express this phenotype.

160. (1) Down's syndrome
Mongolian Idiocy is an outdated term for Down's syndrome, which is caused by trisomy of the twenty-first chromosome. This condition results in distinct physical characteristics and developmental delays. It is one of the most common chromosomal abnormalities in humans and typically arises from non-disjunction during the formation of reproductive cells. Modern medicine uses the term Down's syndrome to describe this specific genetic condition.

161. (1) in human beings Y chromosome is active in sex determination
The observation that XXY results in a male in humans but a female in Drosophila proves that the Y chromosome is active in sex determination in humans. In humans, the presence of the SRY gene on the Y chromosome triggers male development. In Drosophila, sex is determined by the ratio of X chromosomes to autosomes, making the Y chromosome irrelevant for sex determination.

162. (3) 1 : 1
A cross between a heterozygous tall plant (Tt) and a homozygous recessive dwarf plant (tt) is a monohybrid test cross. According to the law of segregation, the offspring will inherit alleles in combinations resulting in a one to one phenotypic and genotypic ratio. Half of the progeny will be heterozygous tall (Tt) and the other half will be homozygous recessive dwarf (tt).

163. (3) epistasis
The phenomenon where one gene pair masks or hides the phenotypic effect of another gene pair at a different locus is called epistasis. This genetic interaction can significantly alter Mendelian ratios in the F_2 generation. It differs from dominance, which involves interactions between alleles of the same gene. Epistasis is a key mechanism in the inheritance of complex traits in many organisms.

164. (2) skin colour
In human beings, skin color is a well-known example of a trait governed by multiple genes, also known as polygenic inheritance. This type of inheritance results in a continuous range of phenotypes rather than discrete categories. Each gene involved contributes an additive effect to the final amount of pigment produced, explaining the wide diversity of skin tones observed within the human population globally.

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165. (4) colour blind sons and carrier daughters.
A color-blind woman is homozygous for the recessive X-linked allele and will pass a defective X chromosome to all her offspring. Her sons, inheriting their only X chromosome from her, will all be color blind. Her daughters will inherit a normal X chromosome from their father and a mutant X from their mother, making them all carriers with normal color vision.

166. (4) all normal.
A haemophilic man carries the recessive allele on his only X chromosome. When he marries a normal woman, his sons will receive his Y chromosome and their mother's normal X chromosome, so they will be normal. His daughters will inherit his mutant X chromosome and a normal X from their mother, making them all carriers. Thus, all children will have a normal phenotype.

167. (1) He would not have discovered the law of independent assortment.
If Mendel had studied seven traits in a plant with only twelve chromosomes instead of fourteen, some of the genes for those traits would likely have been linked on the same chromosome. This linkage would have prevented them from assorting independently. Consequently, Mendel might not have discovered the law of independent assortment, as his observations would have deviated from the expected ratios.

168. (2) recombination of linked alleles
Crossing over is the process that occurs during meiosis where homologous chromosomes exchange segments of DNA. This mechanism is responsible for the recombination of linked alleles, creating new genetic combinations in the offspring. By breaking up existing linkage groups, crossing over increases genetic diversity within a population, which is essential for evolution and adaptation to changing environmental conditions over successive biological generations.

169. (4) Four
The number of genetically different gametes produced by an organism is determined by the formula two to the power of n, where n represents the number of heterozygous gene pairs. In the genotype AABbCc, there are two heterozygous pairs (Bb and Cc). Therefore, two to the power of two equals four. The plant will produce four distinct types of gametes: ABC, ABc, AbC, and Abc.

170. (2) pleiotropy
Pleiotropy is the genetic phenomenon where a single gene exerts influence over multiple, seemingly unrelated phenotypic traits. This often occurs because the gene encodes a protein that plays a role in various metabolic pathways or is used in different tissues during development. A mutation in a pleiotropic gene can therefore lead to a complex syndrome affecting many different parts of an organism's body.

171. (1) 50% haemophilic colour-blind sons and 50% haemophilic sons.
The woman is homozygous for haemophilia and heterozygous for color blindness. All her sons will be haemophilic because they inherit an X chromosome with the haemophilia allele. Half of these sons will also be color blind if they inherit the X chromosome carrying both mutations. Her daughters will all be carriers for both conditions but will have normal phenotypes since the father is normal.

172. (4) increase in X complement.
Mental retardation in humans associated with sex chromosomal abnormalities is frequently linked to an increase in the number of X chromosomes. Conditions like Klinefelter's syndrome (XXY) or Triple X syndrome (XXX) often involve varying degrees of cognitive impairment. The presence of extra X chromosomes disrupts the normal balance of gene expression during development, which can negatively impact brain function and lead to retardation.

173. (4) 25%
Albinism is an autosomal recessive disorder. If two parents with normal pigmentation have an albino child, they must both be heterozygous carriers. According to Mendelian principles, each subsequent child has an independent twenty-five percent chance of being homozygous recessive and thus an albino. The birth of the first albino child does not change the probability for the second child or any future offspring.

174. (3) 1 : 1
In Drosophila, males are the heterogametic sex (XY) and produce two types of gametes in equal proportions: those containing an X chromosome and those containing a Y chromosome. During fertilization, these two types of sperm have an equal chance of entering the egg. Therefore, the proportion of male-specific Y-chromosomes

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entering the egg cell is one to one relative to the X-chromosomes.

175. (1) sex-chromosome
The genetic identity and sex of a human male are determined by his sex chromosomes, specifically the presence of one X and one Y chromosome. The Y chromosome contains the SRY gene, which is essential for initiating male development. While autosomes carry the majority of genetic information, the sex chromosomes are responsible for the primary sexual differentiation that distinguishes males from females.

176. (2) Klinefelter's syndrome
An individual with the sex chromosome configuration XXY suffers from Klinefelter's syndrome. This chromosomal disorder occurs in males and is characterized by the presence of an extra X chromosome. Affected individuals typically exhibit masculine development along with some feminine traits, such as breast enlargement. They are usually sterile and may experience other health issues. This condition results from non-disjunction during the formation of gametes.

177. (2) complementary genes
Complementary genes are two dominant, independently assorting genes that must both be present to produce a specific phenotype. If either gene is present in its recessive form, the trait will not be expressed. This type of gene interaction leads to a nine to seven phenotypic ratio in the F_2 generation. It highlights the cooperation between different loci in controlling a single biological characteristic.

178. (3) different phenotypes
Polygenic genes are multiple genes that together control a single character, such as height or skin color. Because each allele has an additive effect, the interaction of these genes leads to a wide range of different phenotypes in a population. This results in continuous variation rather than discrete categories, which is why individuals with polygenic traits show many distinct and measurable outward appearances.

179. (4) gynandromorph.
An animal that possesses both male and female physical characteristics, often in different parts of its body, is called a gynandromorph. This condition can occur due to the loss of a sex chromosome during early embryonic development. It differs from hermaphroditism, where an individual has both types of reproductive organs. Gynandromorphs provide a unique visual representation of the chromosomal basis of sex determination.

180. (2) Klinefelter's syndrome
Klinefelter's syndrome is a genetic disorder where a male has an extra X chromosome, resulting in an XXY karyotype. This condition leads to a variety of physical and reproductive symptoms, including underdeveloped testes and sterility. While Down's syndrome involves an extra autosome and Turner's syndrome involves a missing X chromosome, Klinefelter's is specifically defined by this extra sex chromosome in an otherwise male individual.

181. (4) all daughters normal.
The man has normal vision because his father's color blindness cannot be passed to a son. The lady has a fifty percent chance of being a carrier because her mother was a carrier (having inherited a defective X from the color-blind maternal grandfather). In a marriage between a normal man and a carrier woman, all daughters will have normal vision, though half will be carriers. This is because every daughter receives a normal X.

182. (3) Sex-linked disease
A disease where an affected father passes the trait only to his daughters as carriers and none of his sons is a sex-linked recessive disorder. The father passes his only X chromosome to all his daughters, making them carriers if the mother is normal. Sons, however, receive only the Y chromosome from their father, and thus they remain unaffected by the X-linked gene.

183. (3) pseudoalleles
When two genetic loci are closely linked and produce a mutant phenotype in the trans position but a wild-type phenotype in the cis position, they are considered to be pseudoalleles. These are genes that are functionally related and located very close to each other on a chromosome. They were once thought to be the same gene but can be separated by rare crossing over events during meiosis.

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184. (1) epistasis
Epistasis is the genetic phenomenon in which the allele of one gene masks or suppresses the phenotypic expression of an allele of a different gene at a separate locus. This interaction can modify Mendelian ratios and is a common feature in the inheritance of complex traits. It differs from simple dominance, which involves interactions between alleles of the same gene at the same locus.

185. (2) sickle cell anaemia
Sickle cell anemia is the most striking and well-studied example of a point mutation in humans. It results from a single base substitution in the DNA that changes one amino acid in the beta-globin chain of hemoglobin. This tiny molecular error has profound effects on the shape of red blood cells and the overall health of the individual, illustrating the power of genetic changes.

186. (2) Klinefelter's syndrome
Klinefelter's syndrome is the condition characterized by a human male possessing an extra X chromosome, resulting in a forty-seven, XXY karyotype. This chromosomal abnormality leads to masculine development that is often incomplete, accompanied by feminine traits like gynecomastia. It typically results in sterility. This syndrome is a primary example of aneuploidy affecting sex chromosomes, caused by non-disjunction during the process of gamete formation.

187. (3) AB and O
A child with blood group O must inherit a recessive i allele from each parent. Therefore, both parents must carry at least one i allele. Parents with blood groups AB and O cannot have an O child because the AB parent only possesses IA and IB alleles and cannot contribute the required recessive i allele. This makes the birth of an O child impossible.

188. (2) holandric genes
Genes that are located only on the non-homologous or differential region of the Y chromosome are known as holandric genes. These genes are transmitted directly from father to son and are never found in females. A classic example in humans is the SRY gene, which is responsible for male sex determination. Because they lack a counterpart on the X chromosome, they show unique inheritance.

189. (1) Tyrosinase
Albinism is a congenital disorder characterized by the complete or partial absence of pigment in the skin, hair, and eyes. It results from a deficiency in the enzyme tyrosinase, which is essential for the production of melanin from the amino acid tyrosine. Without functional tyrosinase, the body cannot synthesize the pigments that provide color and protection from ultraviolet radiation to these tissues.

190. (2) genes for characters are located on the sex-chromosomes
Color blindness is more frequent in males because the genes responsible for distinguishing colors are located on the X chromosome. Since males have only one X chromosome, a single recessive allele will be expressed. Females have two X chromosomes, so they would need two recessive alleles to be affected. This sex-linked inheritance pattern makes males hemizygous for these traits and thus more vulnerable.

191. (2) AABB × aabb
For an experiment on linkage, a cross between a homozygous dominant individual and a homozygous recessive individual for two traits is most suitable. This setup, such as AABB times aabb, produces a dihybrid F_1 generation. By then performing a test cross of the F_1 with the double recessive parent, researchers can easily track the inheritance of the parental and recombinant allele combinations.

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192. (4) absent/incomplete.
When two genes are fifty map units apart, they show a fifty percent recombination frequency, which is the maximum possible. This indicates that the genes are either on different chromosomes or are so far apart on the same chromosome that they assort independently. In such cases, linkage is considered to be absent or incomplete, as the genes do not tend to stay together.

193. (2) Mendel might not have studied all the combinations
Mendel studied seven characters in peas, but he did not examine every possible combination of these traits in dihybrid crosses. If later studies showed that some traits do not assort independently, it would likely be because the

genes for those traits are linked on the same chromosome. This does not invalidate Mendel's principles but rather clarifies the physical basis of chromosomal inheritance.

194. (1) skin colour
Human skin color is a classic example of polygenic inheritance, where the trait is controlled by the cumulative effect of several genes. Each gene has a small additive influence on the total amount of melanin produced. This leads to a continuous variation in phenotypes across the population, rather than discrete categories. Other conditions like sickle cell anemia and color blindness follow simpler inheritance patterns.

195. (3) 1/4
Mr. Kapoor is heterozygous for the autosomal gene B (Bb) and hemizygous for the sex-linked allele d (XdY). To produce a sperm with the genotype Bd, he must contribute the dominant B allele and the X chromosome carrying the d allele. The probability of each is one-half. Multiplying these probabilities (one-half times one-half) gives a final proportion of one-fourth for Bd sperms.

196. (2) at time of fertilisation
In human beings, sex is determined at the exact moment of fertilization. It depends on whether the sperm that fertilizes the egg carries an X chromosome or a Y chromosome. Fertilization by an X-bearing sperm results in a female zygote (XX), while fertilization by a Y-bearing sperm results in a male zygote (XY). The chromosomal makeup of the zygote then directs development.

197. (4) possible only when mother's father was colour blind.
If both parents have normal vision, a male child can only be color blind if the mother is a carrier. The mother would have inherited the recessive X-linked allele from one of her parents. Specifically, if her father was color blind, he would have passed the defective X chromosome to her. Therefore, the chance depends on the maternal grandfather being affected by the condition.

198. (3) one X-chromosome of mother
This specific inheritance pattern indicates that the mother is a heterozygous carrier of the haemophilia gene. She has one normal X chromosome and one X chromosome carrying the recessive mutation. Half of her sons will inherit the mutant chromosome and be affected, while half of her daughters will inherit it and become carriers like their mother. The father must have a normal X chromosome.

199. (4) IBIO.
For a child to have blood group O (genotype ii), they must inherit one i allele from each parent. If the father has blood group B, he must carry the recessive i allele to pass it on to his child. Therefore, the father's genotype must be heterozygous, specifically IBIO. A homozygous IBIB father could not produce a child with the O blood group.

200. (1) both homozygous and heterozygous states
An allele is defined as dominant if it is expressed in both the homozygous and the heterozygous states. This means its phenotypic effect is observable whether there are two copies of the allele or just one. In the heterozygous condition, the dominant allele masks the presence of the recessive allele. This concept is central to Mendelian genetics and the prediction of phenotypic outcomes.

201. (4) homozygous.
An organism that possesses two identical alleles for a particular gene is described as being homozygous for that trait. This can be either homozygous dominant, with two dominant alleles, or homozygous recessive, with two recessive alleles. Homozygous individuals produce only one type of gamete for that specific gene, which ensures that their offspring will inherit that specific version of the trait from them.

202. (3) 1 : 2 : 2 : 1
In the F_2 generation of a dihybrid cross starting from AABB and aabb, the specific genotypes AABB, AaBB, Aabb, and aabb occur in a predictable ratio. Based on the Punnett square for sixteen combinations, AABB appears once, AaBB appears twice, Aabb appears twice, and aabb appears once. This gives a final ratio of one to two to two to one for these.

203. (1) anaphase I
The segregation of Mendelian factors, or alleles, occurs during anaphase I of meiosis. During this stage, homologous chromosomes, each carrying one of the alleles, are pulled apart to opposite poles of the cell. This physical separation ensures that each gamete receives only one allele for each

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disease. Females have two X chromosomes and would need to inherit two copies of the recessive allele to be affected, which is a statistically rarer event than inheriting just one.

224. (4) Phenylketonuria
Phenylketonuria is a classic example of a hereditary disease, specifically an autosomal recessive metabolic disorder. It is caused by a mutation in the gene for the enzyme phenylalanine hydroxylase. If left untreated, it leads to the accumulation of phenylalanine, causing mental retardation. In contrast, conditions like cataracts, leprosy, and most forms of general blindness are typically acquired through environmental factors, age, or infections.

225. (1) 0%
A husband and wife with normal vision whose fathers were color blind means the wife is a carrier, but the husband has a normal X chromosome. A daughter inherits one X chromosome from each parent. Since the husband only has a normal X to give, all daughters will receive at least one normal allele. Therefore, the probability of a daughter being color blind is zero.

226. (3) ++ : 40 : : ab : 40 : : + a : 10 : : + b : 10
A recombination frequency of twenty percent means that twenty percent of the gametes will be recombinants and eighty percent will be parental types. In a cross between ++/++ and ab/ab, the F_1 is ++/ab. The parental gametes are ++ and ab, each occurring at forty percent. The recombinant gametes are +a and +b, each occurring at ten percent, totaling twenty percent.

227. (3) plastids are inherited from female parent
In maize, the trait for albinism is often inherited through the cytoplasm, which contains plastids like chloroplasts. During fertilization, the zygote receives its cytoplasm and organelles almost entirely from the female parent's egg cell, while the sperm contributes mainly nuclear DNA. Therefore, if the female parent is albino, the progeny will also be albino because they inherit her defective plastids via the cytoplasm.

228. (4) Consideration of one character at one time
One of the primary reasons for Mendel's success was his decision to consider only one character at a time during his initial experiments. This simplified approach allowed him to observe clear mathematical patterns and ratios in the offspring that would have been obscured if he had tracked many traits simultaneously. His focus on discrete, contrasting traits provided a solid foundation for deducing inheritance laws.

229. (3) only one allele for each gene in the individual
Haploid organisms are able to express both recessive and dominant alleles because they possess only one allele for each gene in their cells. Unlike diploid organisms, there is no second allele present to mask the expression of a recessive mutation. Consequently, any genetic change, whether dominant or recessive, is immediately reflected in the phenotype of the organism, making them useful for genetic research.

230. (3) 50%
In humans, the sex of each child is determined independently at the time of fertilization. The probability of having a son or a daughter is always approximately fifty percent for each pregnancy, regardless of the gender of previous children. Therefore, even if a family already has five daughters, the chance of the sixth child being a son remains exactly fifty percent.

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pink. This differs from complete dominance where the heterozygote would look like the dominant parent, and from codominance where both parental traits would be visible simultaneously.

214. (4) recessive.
An allele that is unable to express its phenotypic effect in the presence of another allele of the same gene is called a recessive allele. Its presence is masked by the dominant allele in a heterozygous individual. Recessive traits only become visible when an organism is homozygous for that specific allele, meaning it has inherited two copies of the recessive gene from its parents.

215. (2) her father and maternal grand father were colour blind
A girl being color blind is rare because color blindness is an X-linked recessive trait. For a girl to express the condition, she must inherit a defective X chromosome from both parents. This means her father must be color blind and her mother must be at least a carrier. Her maternal grandfather must also have been color blind to pass the allele to her mother.

216. (3) multiple allelism
The ABO blood group system in humans is a primary example of multiple allelism. Unlike traits controlled by only two alleles, this system involves three alleles: IA, IB, and i. These alleles interact to produce the various blood types seen in the population. Additionally, this system demonstrates co-dominance between the IA and IB alleles, further increasing the variety of possible phenotypic outcomes.

217. (2) 50% recessive
Crossing a homozygous recessive plant (tt) with a heterozygous plant (Tt) results in offspring with a one to one ratio of genotypes. Specifically, half of the progeny will be heterozygous (Tt) and express the dominant trait, while the other half will be homozygous recessive (tt) and express the recessive trait. Therefore, fifty percent of the offspring will have the recessive characteristic.

218. (1) 1AaBB : 1aaBB
In a cross between AaBB and aaBB, the first parent produces gametes AB and aB, while the second parent produces only aB gametes. Combining these results in two offspring genotypes: AaBB and aaBB, produced in equal frequencies. This gives a ratio of one to one. The trait controlled by the homozygous B gene remains constant, while the A gene follows monohybrid segregation.

219. (3) 9 : 3 : 4
In a genetic cross involving recessive epistasis, the typical nine to three to three to one dihybrid phenotypic ratio is modified into a nine to three to four ratio in the F_2 generation. This occurs because the homozygous recessive state of one gene masks the phenotypic expression of the other gene, regardless of its alleles. This interaction is a common deviation from Mendelian inheritance.

220. (4) Coupling AABB, aabb; Repulsion AAbb, aaBB
Coupling refers to the situation where two dominant alleles are on one chromosome and two recessive alleles are on the other (AABB, aabb). Repulsion occurs when each chromosome has one dominant and one recessive allele (AAbb, aaBB). These terms were used by Bateson to describe deviations from independent assortment, which were later understood by Morgan as being due to physical linkage on chromosomes.

221. (2) anaphase I
The segregation of Mendelian factors, such as the alleles A and a in a heterozygote, occurs during anaphase I of meiosis. This is the stage when homologous chromosomes separate and move toward opposite poles of the dividing cell. As a result, each resulting daughter cell and subsequent gamete receives only one of the two alleles, fulfilling the fundamental principle of the law of segregation.

222. (2) XY
In a male child with Down's syndrome, the sex chromosome complement remains a normal XY. Down's syndrome is an autosomal disorder caused by an extra copy of chromosome twenty-one, not a sex chromosome abnormality. Therefore, the individual has forty-five autosomes plus two sex chromosomes, totaling forty-seven. While they have three copies of chromosome twenty-one, their sex determination remains governed by the standard XY system.

223. (4) recessive trait carried by X-chromosome.
Haemophilia is more prevalent in males because it is an X-linked recessive trait. Males possess only one X chromosome, so a single defective allele inherited from the mother will result in the

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gene, which is the fundamental basis of Mendel's first law, the law of segregation in genetics.

204. (1) colour blind sons and normal/carrier daughters
A color-blind mother is homozygous for the recessive X-linked allele and will pass a defective X chromosome to all her children. All her sons will inherit this mutant chromosome and be color blind. All her daughters will inherit a normal X chromosome from their father and a mutant X from their mother, making them all normal-visioned carriers of the trait in their progeny.

205. (4) non-disjunction of chromosomes.
Down's syndrome is primarily caused by the non-disjunction of chromosomes during meiosis, usually during the formation of an egg cell. This failure of chromosomes to separate correctly results in a gamete with an extra copy of chromosome twenty-one. Upon fertilization, the resulting zygote has three copies of this chromosome, leading to the various physical and developmental characteristics that define this genetic condition.

206. (3) Turner's syndrome
A chromosomal abnormality in humans involving forty-five chromosomes with a single X and no second sex chromosome (XO) causes Turner's syndrome. This condition affects females and typically leads to short stature, underdeveloped secondary sexual characteristics, and sterility. It is a classic example of monosomy in humans, resulting from non-disjunction of sex chromosomes during the process of gamete formation in one of the parents.

207. (2) Mendel
Gregor Mendel is universally recognized as the father of genetics. In the mid-nineteenth century, he conducted pioneering experiments with garden pea plants, meticulously tracking the inheritance of specific traits across generations. His discovery of the fundamental laws of dominance, segregation, and independent assortment laid the scientific groundwork for the modern field of genetics, even though his work was not fully appreciated.

208. (4) B
If a man with blood group A marries a woman with blood group AB, the presence of a child with blood group B would indicate that the man is heterozygous. This is because a group B child must inherit the IB allele from the mother and the recessive i allele from the father. If the father were homozygous AA, he could only contribute an A.

209. (4) blood groups.
In humans, the inheritance of blood groups is a well-known example controlled by multiple alleles. The ABO system is governed by three alleles of the I gene: IA, IB, and i. This differs from simple Mendelian inheritance where only two alleles exist for a gene. The presence of these three alleles allows for four different phenotypes and six genotypes within the human population.

210. (2) allelomorphs
In Mendelian genetics, the contrasting pairs of factors that control a specific character and occupy the same locus on homologous chromosomes are called allelomorphs, or more commonly, alleles. For example, the factors for tall and dwarf height in pea plants are allelomorphs. The interaction between these alleles determines the final genotype and phenotype of the individual for that particular inherited trait or character.

211. (3) independent assortment
Mendel's last law is the law of independent assortment. It states that the alleles of two or more different genes get sorted into gametes independently of one another. In other words, the allele a gamete receives for one gene does not influence the allele received for another gene. This law was derived from his observations of dihybrid crosses involving two different plant traits.

212. (1) both blue eyed and brown eyed 1 : 1
Brown eye color is dominant over blue. A brown-eyed man whose mother was blue-eyed must be heterozygous (Bb). If he marries a blue-eyed woman (bb), their cross is a test cross. According to Mendelian segregation, fifty percent of their children will inherit the Bb genotype and have brown eyes, while the other fifty percent will be homozygous recessive bb and have blue eyes.

213. (2) incomplete dominance
This cross is a classic example of incomplete dominance. In this type of inheritance, neither allele is completely dominant over the other. The heterozygous offspring (RW) exhibit an intermediate phenotype, which in this case is

NODIA

CHAPTER 24

Molecular Basis of Inheritance

2026 (RE-NEET)

1. Which of the following statements about lac-operon is correct?
(1) Genes i, z, y and a share single common promoter
(2) Galactose can act as an inducer of lac operon
(3) Gene i is constitutively expressed
(4) Lactose activates repressor to bind to the operator

2026 (RE-NEET)

2. Which of the following enzymes synthesizes precursor mRNA?
(1) RNA polymerase III
(2) DNA polymerase
(3) RNA polymerase I
(4) RNA polymerase II

2026 (CANCELLED)

3. In the lac operon, the z gene codes for:
(1) permease
(2) transacetylase
(3) beta-galactosidase
(4) the repressor of lac operon

2026 (CANCELLED)

4. Which of the following statements are correct with reference to a transcription unit?
A. A transcription unit in DNA is defined primarily by three regions: promoter, structural gene and terminator.
B. The promoter is said to be located towards the 5'-end of the structural gene.
C. The promoter is a DNA sequence that provides binding site for RNA polymerase.
D. The promoter defines the template and coding strands.
E. The terminator is located towards the 3'-end of the coding strand and it defines the end of the process of transcription.
(1) A, B, C and D only
(2) A, C, D and E only
(3) B, C, D and E only
(4) A, B, C, D and E

2026 (CANCELLED)

5. Which of the following statements are correct with reference to packaging of DNA helix?
A. Histones are organized to form a unit of eight molecules called histone octamer.
B. Histones are negatively charged basic proteins.
C. Histones are rich in the basic amino acid residues - lysine and arginine.
D. The positively charged DNA is wrapped around the histone octamer to form nucleosome.
E. The packaging of chromatin at higher levels requires an additional set of proteins called non-histone chromosomal proteins.
(1) A, C and E only
(2) B, D and E only
(3) C, D and E only
(4) A, B and D only

2026 (CANCELLED)

6. The sixth mutant codon of beta globin gene causing polymerization of Haemoglobin and change in RBC shape is:
(1) GUG (2) AUG
(3) GAG (4) CAG

2025

7. Histones are enriched with
(1) phenylalanine and leucine
(2) phenylalanine and arginine
(3) lysine and arginine
(4) leucine and lysine.

2025

8. Match List I with List II.

	List-I		List-II
A.	Alfred Hershey and Martha Chase	I.	Streptococcus pneumoniae
B.	Euchromatin	II.	Densely packed and dark-stained
C.	Frederick Griffith	III.	Loosely packed and light-stained
D.	Heterochro-matin	IV.	DNA as genetic material confirmation

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Choose the correct answer from the options given below.
(1) A-IV, B-III, C-I, D-II
(2) A-III, B-II, C-IV, D-I
(3) A-II, B-IV, C-I, D-III
(4) A-IV, B-II, C-I, D-III

2025

9. Given below are two statements:
Statement I: In the RNA world, RNA is considered the first genetic material evolved to carry out essential life processes. RNA acts as a genetic material and also as a catalyst for some important biochemical reactions in living systems. Being reactive, RNA is unstable.
Statement II: DNA evolved from RNA and is a more stable, genetic material. Its double helical strands being complementary, resist changes by evolving repairing mechanism.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

2025

10. Which of the following are the post-transcriptional events in an eukaryotic cell?
A. Transport of pre-mRNA to cytoplasm prior to splicing.
B. Removal of introns and joining of exons.
C. Addition of methyl group at 5' end of hnRNA.
D. Addition of adenine residues at 3' end of hnRNA.
E. Base pairing of two complementary RNAs.
Choose the correct answer from the options given below.
(1) B, C, E only
(2) C, D, E only
(3) A, B, C only
(4) B, C, D only

2025

11. Which factor is important for termination of transcription?
(1) ρ (rho) (2) γ (gamma)
(3) α (alpha) (4) σ (sigma)

2025

12. Who proposed that the genetic code for amino acids should be made up of three nucleotides?
(1) Jacque Monod
(2) Franklin Stahl
(3) George Gamow
(4) Francis Crick

NODIA

2025

13. Which chromosome in the human genome has the highest number of genes?
(1) Chromosome 1 (2) Chromosome 10
(3) Chromosome X (4) Chromosome Y

2025

14. Twins are born to a family that lives next door to you. The twins are a boy and a girl. Which of the following must be true?
(1) They were conceived through in vitro fertilisation.
(2) They have 75% identical genetic content.
(3) They are monozygotic twins.
(4) They are fraternal twins.

RE-EXAM 2024

15. Match List-I with List-II.

	List-I		List-II
A.	Histones chromatin	I.	Loosely packed
B.	Nucleosome chromatin	II.	Densely packed
C.	Euchromatin	III.	Positively charged basic proteins
D.	Heterochromatin	IV.	DNA wrapped around histone octamer

Choose the correct answer from the options given below.
(1) A-IV, B-III, C-II, D-I
(2) A-III, B-I, C-IV, D-II
(3) A-II, B-III, C-IV, D-I
(4) A-III, B-IV, C-I, D-II

2024

16. Which of the following statement is correct regarding the process of replication in E. coli?
(1) The DNA dependent DNA polymerase catalyses polymerisation in one direction that is 3' $\rightarrow$ 5'.
(2) The DNA dependent RNA polymerase catalyses polymerisation in one direction that is 5' $\rightarrow$ 3'.

(3) The DNA dependent DNA polymerase catalyses polymerisation in 5' → 3' as well as 3' → 5'.
(4) The DNA dependent DNA polymerase catalyses polymerisation in 5' → 3' direction.

RE-EXAM 2024

17. Given below are two statements regarding RNA polymerase in prokaryotes.
Statement I : In prokaryotes, RNA polymerase is capable of catalysing the process of elongation during transcription.
Statement II : RNA polymerase associate transiently with 'rho' factor to initiate transcription.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

RE-EXAM 2024

18. Given below are two statements.
Statement I : In eukaryotes, there are three RNA polymerases in the nucleus in addition to the RNA polymerase found in the organelles.
Statement II : All the three RNA polymerases in eukaryotic nucleus have different roles.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

2024

19. Which one is the correct product of DNA dependent RNA polymerase to the given template?
3'TACATGGCAAATATCCATTCA 5'
(1) 5'AUGUACCGUUUAUAGGUAAGU 3'
(2) 5'AUGUAAAGUUUAUAGGUAAGU 3'
(3) 5'AUGUACCGUUUAUAGGGAAGU 3'
(4) 5'ATGTACCGTTTATAGGTAAGT 3'

2024

20. Match List I with List II.

	List-I		List-II
A.	RNA polymerase III	I.	snRNPs
B.	Termination of transcription	II.	Promotor
C.	Splicing of exons	III.	Rho factor
D.	TATA box	IV.	SnRNAs, tRNA

Choose the correct answer from the options given below :
(1) A-II, B-IV, C-I, D-III
(2) A-III, B-II, C-IV, D-I
(3) A-III, B-IV, C-I, D-II
(4) A-IV, B-III, C-I, D-II

2024

21. A transcription unit in DNA is defined primarily by the three regions in DNA and these are with respect to upstream and down stream end
(1) repressor, operator gene, structural gene
(2) structural gene, transposons, operator gene
(3) inducer, repressor, structural gene
(4) promotor, structural gene, terminator.

RE-EXAM 2024

22. Given below are two statements.
Statement I : In the lac operon, the z gene codes for beta-galactosidase which is primarily responsible for the hydrolysis of lactose into galactose and glucose.
Statement II : In addition to lactose, glucose or galactose can also induce lac operon.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

NODIA

2024

23. The lactose present in the growth medium of bacteria is transported to the cell by the action of
(1) beta-galactosidase
(2) acetylase
(3) permease
(4) polymerase.

2024

24. Match List I with List II.

	List-I		List-II
A.	Frederick Griffith	I.	Genetic code
B.	Francois Jacob & Jacque Monod	II.	Semi-conservative mode of DNA replication
C.	Har Gobind Khorana	III.	Transformation
D.	Meselson & Stahl	IV.	Lac operon

Choose the correct answer from the options given below.
(1) A-III, B-II, C-I, D-IV
(2) A-III, B-IV, C-I, D-II
(3) A-II, B-III, C-IV, D-I
(4) A-IV, B-I, C-II, D-III

2023

25. Given below are two statements:
Statement I: In prokaryotes, the positively charged DNA is held with some negatively charged proteins in a region called nucleoid.
Statement II: In eukaryotes, the negatively charged DNA is wrapped around the positively charged histone octamer to form nucleosome.
In the light of the above statements, choose the correct answer from the options given below:
(1) Statement I is correct but Statement II is false.
(2) Statement I incorrect but Statement II is true.
(3) Both Statement I and Statement II are true.
(4) Both Statement I and Statement II are false.

Manipur NEET 2023

26. With reference to Hershey and Chase experiments.
Select the correct statements.
(A) Viruses grown in the presence of radioactive phosphorus contained radioactive DNA.
(B) Viruses grown on radioactive sulphur contained radioactive proteins.
(C) Viruses grown on radioactive phosphorus contained radioactive protein.
(D) Viruses grown on radioactive sulphur contained radioactive DNA.
(E) Viruses grown on radioactive protein contained radioactive DNA.
Choose the most appropriate answer from the options given below.
(1) (D) and (E) only
(2) (A) and (B) only
(3) (A) and (C) only
(4) (B) and (D) only

Manipur NEET 2023

27. Which scientist conducted an experiment with 32P and 35S labelled phages for demonstrating that DNA is the genetic material?
(1) James D. Watson and F.H.C. Crick
(2) A.D Hershey and M.J. Chase
(3) F. Griffith
(4) O.T. Avery, C.M. MacLeod and M. McCarty

2023

28. Given below are two statements:
Statement I: RNA mutates at a faster rate.
Statement II: Viruses having RNA genome and shorter life span mutate and evolve faster.
In the light of the above statements, choose the correct answer from the options given below:
(1) Statement I is true but Statement II is false.
(2) Statement I false but Statement II is true.
(3) Both Statement I and Statement II are true.
(4) Both Statement I and Statement II are false.

2023

29. Unequivocal proof that DNA is the genetic material was first proposed by
(1) Avery, Macleoid and McCarthy
(2) Wilkins and Franklin
(3) Frederick Griffith
(4) Alfred Hershey and Martha Chase

Manipur NEET 2023

30. Given below are two statements.
Statement I : RNA being unstable, mutate at a faster rate.
Statement II : RNA can directly code for synthesis of proteins hence can easily express the characters.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is correct but statement II is false.
(2) Statement I is incorrect but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

Manipur NEET 2023

31. Given below are two statements :
Statement I : The process of copying genetic information from one strand of the DNA into RNA is termed as transcription.

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Statement II : A transcription unit in DNA is defined primarily by the three regions in the DNA i.e., a promotor, the structural gene and a terminator.

In the light of the above statements, choose the correct answer from the options given below.

(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

2023

32. What is the role of RNA polymerase III in the process of transcription in Eukaryotes?

(1) Transcription of precursor of mRNA
(2) Transcription of only snRNAs
(3) Transcription of rRNAs (28S, 18S and 5.8S)
(4) Transcription of tRNA, 5 SrRNA and snRNA

2023

33. Which one of the following is the sequence on corresponding coding strand, if the sequence on mRNA formed is as follows.

5' AUCGAUCGAUCGAUCGAUCGAUCG 3'?

(1) 5' ATCGATCGATCGATCGATCGATCG 3'
(2) 3' ATCGATCGATCGATCGATCGATCG 5'
(3) 5' GCUAGCUAGCUAGCUAGCUAGCUAGC 3'
(4) 3' GCUAGCUAGCUAGCUAGCUAGCUAGC 5'

Manipur NEET 2023

34. The salient features of genetic code are

(A) The code is palindromic.
(B) UGA act as initiator codon.
(C) The code is unambiguous and specific.
(D) The code is nearly universal.

Choose the most appropriate answer from the options given below.

(1) (A) and (D) only
(2) (B) and (C) only
(3) (A) and (B) only
(4) (C) and (D) only

Manipur NEET 2023

35. Select the correct statements about sickle cell anaemia.

(A) There is a change in gene for beta globin.
(B) In the beta globin, there is valine in the place of lysine.
(C) It is an example of point mutation.
(D) In the normal gene U is replaced by (A)

Choose the correct answer from the options given below.

(1) (B), (C) and (D) only
(2) (B) and (D) only
(3) (A), (B) and (D) only
(4) (A) and (C) only

Manipur NEET 2023

36. Which one of the following acts as an inducer for lac operon?

(1) Sucrose
(2) Lactose
(3) Glucose
(4) Galactose

Manipur NEET 2023

37. Name the component that binds to the operator region of an operon and prevents RNA polymerase from transcribing the operon.

(1) Promotor
(2) Regulator protein
(3) Repressor protein
(4) Inducer

2023

38. Match List I with List II.

	List-I		List-II
A.	Gene 'a'	I.	β-galactosidase
B.	Gene 'y'	II.	Transacetylase
C.	Gene 'i'	III.	Permease
D.	Gene 'z'	IV.	Repressor protein

Choose the correct answer from the options given below:

(1) A-III, B-IV, C-I, D-II
(2) A-III, B-I, C-IV, D-II
(3) A-II, B-I, C-IV, D-III
(4) A-II, B-III, C-IV, D-I

Manipur NEET 2023

39. The last chromosome sequenced in Human Genome Project was

(1) chromosome 6
(2) chromosome 1
(3) chromosome 22
(4) chromosome 14.

2023

40. Expressed Sequence Tags (ESTs) refers to

(1) all genes whether expressed or unexpressed
(2) certain important expressed genes
(3) all genes that are expressed as RNA
(4) all genes that are expressed as proteins

NODIA

NEET-I 2016

87. A complex of ribosomes attached to a single strand of RNA is known as
(1) polypeptide
(2) Okazaki fragment
(3) polysome
(4) polymer.

NEET-I 2016

88. Which of the following is required as inducer(s) for the expression of Lac operon?
(1) Lactose
(2) Lactose and galactose
(3) Glucose
(4) Galactose

NEET-I 2016

89. Which of the following is not required for any of the techniques of DNA fingerprinting available at present?
(1) Restriction enzymes
(2) DNA-DNA hybridisation
(3) Polymerase chain reaction
(4) Zinc finger analysis

2015 Cancelled

90. In sea urchin DNA, which is double stranded, 17% of the bases were shown to be cytosine. The percentages of the other three bases expected to be present in this DNA are
(1) G 17%, A 33%, T 33%
(2) G 8.5%, A 50%, T 24.5%
(3) G 34%, A 24.5%, T 24.5%
(4) G 17%, A 16.5%, T 32.5%.

2015

91. Which one of the following is not applicable to RNA?
(1) Heterocyclic nitrogenous bases
(2) Chargaff's rule
(3) Complementary base pairing
(4) 5' phosphoryl and 3' hydroxyl ends

2015 Cancelled

92. Gene regulation governing lactose operon of E.coli that involves the lac I gene product is
(1) negative and repressible because repressor protein prevents transcription
(2) feedback inhibition because excess of β-galactosidase can switch off transcription
(3) positive and inducible because it can be induced by lactose
(4) negative and inducible because repressor protein prevents transcription.

2015

93. Identify the correct order of organisation of genetic material from largest to smallest.
(1) Genome, chromosome, gene, nucleotide
(2) Chromosome, genome, nucleotide, gene
(3) Chromosome, gene, genome, nucleotide
(4) Genome, chromosome, nucleotide, gene

2015

94. Satellite DNA is important because it
(1) does not code for proteins and is same in all members of the population
(2) codes for enzymes needed for DNA replication
(3) codes for proteins needed in cell cycle
(4) shows high degree of polymorphism in population and also the same degree of polymorphism in an individual, which is heritable from parents to children.

2014

95. Transformation was discovered by
(1) Meselson and Stahl
(2) Hershey and Chase
(3) Griffith
(4) Watson and Crick.

2014

96. Select the correct option.

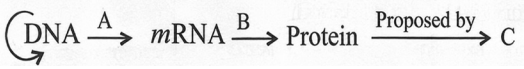
	Direction of RNA synthesis	**Direction of reading of the template DNA** strand
(1)	5' - 3'	3' - 5'
(2)	3' - 5'	5' - 3'
(3)	5' - 3'	5' - 3'
(4)	3' - 5'	3' - 5'

2014

97. Which one of the following is wrongly matched?
(1) Transcription - Writing information from DNA to tRNA.
(2) Translation - Using information in mRNA to make protein.
(3) Repressor protein - Binds to operator to stop enzyme synthesis.
(4) Operon - Structural genes, operator and promoter.

2013

98. The diagram shows an important concept in the genetic implication of DNA. Fill in the blanks A to C.



(1) A - Transcription, B - Translation, C - Francis Crick

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2021

51. What is the role of RNA polymerase III in the process of transcription in eukaryotes?
(1) Transcribes only snRNAs
(2) Transcribes rRNAs (28S, 18S and 5.8S)
(3) Transcribes tRNA, 5S rRNA and snRNA
(4) Transcribes precursor of mRNA

2021

52. Identify the correct statement.
(1) Split gene arrangement is characteristic of prokaryotes.
(2) In capping, methyl guanosine triphosphate is added to the 3' end of hnRNA.
(3) RNA polymerase binds with Rho factor to terminate the process of transcription in bacteria.
(4) The coding strand in a transcription unit is copied to an mRNA.

2021

53. Which is the "only enzyme" that has "capability" to catalyse initiation, elongation and termination in the process of transcription in prokaryotes?
(1) DNase
(2) DNA dependent DNA polymerase
(3) DNA dependent RNA polymerase
(4) DNA Ligase

2021

54. Given below are two statements:
Statement I : The codon 'AUG' codes for methionine and phenylalanine.
Statement II: 'AAA' and 'AAG' both codons code for the amino acid lysine.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is incorrect but Statement II is true.
(2) Both Statement I and Statement II are true.
(3) Both statement I and Statement II are false.
(4) Statement I is correct but Statement II is false.

2021

55. Which of the following RNAs is not required for the synthesis of protein?
(1) siRNA
(2) mRNA
(3) tRNA
(4) rRNA

2021

56. DNA fingerprinting involves identifying differences in some specific regions in DNA sequence, called as
(1) polymorphic DNA
(2) satellite DNA
(3) repetitive DNA
(4) single nucleotides.

2020

57. Which of the following statements is correct?
(1) Adenine pairs with thymine through two H-bonds.
(2) Adenine pairs with thymine through one H-bond.
(3) Adenine pairs with thymine through three H-bonds.
(4) Adenine does not pair with thymine.

NODIA

2020

58. If the distance between two consecutive base pairs is 0.34 nm and the total number of base pairs of a DNA double helix in a typical mammalian cell is 6.6×10^9 bp, then the length of the DNA is approximately
(1) 2.0 meters
(2) 2.5 meters
(3) 2.2 meters
(4) 2.7 meters.

2020

59. Name the enzyme that facilitates opening of DNA helix during transcription.
(1) DNA ligase
(2) DNA helicase
(3) DNA polymerase
(4) RNA polymerase

2020

60. The first phase of translation is
(1) binding of mRNA to ribosome
(2) recognition of DNA molecule
(3) aminoacylation of tRNA
(4) recognition of an anti-codon.

2019

61. Purines found both in DNA and RNA are
(1) cytosine and thymine
(2) adenine and thymine
(3) adenine and guanine
(4) guanine and cytosine.

Odisha NEET 2019

62. What will be the sequence of mRNA produced by the following stretch of DNA ?
3'ATGCATGCATGCATG5'TEMPLATE STRAND
5' TACGTACGTACGTAC3' CODING STRAND
(1) 3'AUGCAUGCAUGCAUG5'

2022

41. Read the following statements and choose correct statements :
(A) Euchromatin is loosely packed chromatin.
(B) Heterochromatin is transcriptionally active.
(C) Histone octamer is wrapped by negatively charged DNA in nucleosome
(D) Histones are rich in lysine and arginine
(E) A typical nucleosome contains 400 bp of DNA helix.
Choose the correct answer from the option below :
(1) (B), (D), (E) only
(2) (A), (C), (D) only
(3) (B), (E) only
(4) (A), (C), (E) only

2022

42. If the length of a DNA molecule is 1.11 metres, what will be the approximate number of base pairs?
(1) 3.3×10^9 bp
(2) 6.6×10^9 bp
(3) 3.3×10^6 bp
(4) 6.6×10^6 bp

2022

43. Ten E.coli cells with 15N-dsDNA are incubated in medium containing 14N nucleotide. After 60 minutes, how many E. coli cells will have DNA totally free from 15N?
(1) 20 cells
(2) 40 cells
(3) 60 cells
(4) 80 cells

2022

44. The process of translation of mRNA to proteins begins as soon as
(1) the small subunit of ribosome encounter mRNA
(2) the larger subunit of ribosome encounters mRNA
(3) both the subunits join together to bind with mRNA
(4) the tRNA is activated and the larger subunit of ribosome encounters mRNA.

2022

45. In an E.coli strain i gene gets mutated and its product cannot bind the inducer molecule. If growth medium is provided with lactose, what will be the outcome?
(1) Only z gene will get transcribed
(2) z, y, a genes will be transcribed
(3) z, y, a genes will not be translated
(4) RNA polymerase will bind the promoter region

2022

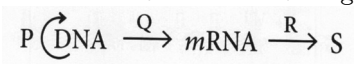
46. If a geneticist uses the blind approach for sequencing the whole genome of an organism, followed by assignment of function to different segments, the methodology adopted by him is called as:
(1) Sequence annotation
(2) Gene mapping
(3) Expressed sequence tags
(4) Bioinformatics

2022

47. DNA polymorphism forms the basis of
(1) genetic mapping
(2) DNA finger printing
(3) both genetic mapping and DNA fingerprinting
(4) translation.

2021

48. Complete the flow chart on central dogma.



(1) (P)-Transduction; (Q)-Translation; (R)-Replication; (S)-Protein
(2) (P)-Replication; (Q)-Transcription; (R)-Transduction; (S)-Protein
(3) (P)-Translation; (Q)-Replication; (R)-Transcription; (S)-Transduction
(4) (P)-Replication; (Q)-Transcription; (R)-Translation; (S)-Protein

2021

49. If adenine makes 30% of the DNA molecule, what will be the percentage of thymine, guanine and cytosine in it?
(1) T : 20 ; G : 25 ; C : 25
(2) T : 20 ; G : 30 ; C : 20
(3) T : 20 ; G : 20 ; C : 30
(4) T : 30 ; G : 20 ; C : 20

2021

50. Which one of the following statements about histones is wrong?
(1) Histones carry positive charge in the side chain.
(2) Histones are organized to form a unit of 8 molecules.
(3) The pH of histones is slightly acidic.
(4) Histones are rich in amino acids - Lysine and Arginine.

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(3) Matthew Meselson and F. Stahl - Pisum sativum
(4) Francois Jacob and Jacques Monod - Lac operon

2018

74. All of the following are part of an operon except
(1) an operator
(2) structural genes
(3) an enhancer
(4) a promoter.

2017

75. The association of histone H1 with a nucleosome indicates that
(1) DNA replication is occurring
(2) the DNA is condensed into a chromatin fibre
(3) the DNA double helix is exposed
(4) transcription is occurring.

2017

76. The final proof for DNA as the genetic material came from the experiments of
(1) Hershey and Chase
(2) Avery, MacLeod and McCarty
(3) Hargobind Khorana
(4) Griffith.

2017

77. During DNA replication, Okazaki fragments are used to elongate
(1) the lagging strand towards replication fork
(2) the leading strand away from replication fork
(3) the lagging strand away from the replication fork
(4) the leading strand towards replication fork.

2017

78. Which of the following RNAs should be most abundant in animal cell?
(1) tRNA
(2) mRNA
(3) miRNA
(4) rRNA

2017

79. Spliceosomes are not found in cells of
(1) fungi
(2) animals
(3) bacteria
(4) plants.

2017

80. If there are 999 bases in an RNA that code for a protein with 333 amino acids, and the base at position 901 is deleted such that the length of the RNA becomes 998 bases, how many codons will be altered?
(1) 11 (2) 33
(3) 333 (4) 1

NEET-II 2016

81. Taylor conducted the experiments to prove semi-conservative mode of chromosome replication on
(1) Vinca rosea
(2) Vicia faba
(3) Drosophila melanogaster
(4) E. coli.

NEET-II 2016

82. A molecule that can act as a genetic material must fulfill the traits given below, except
(1) it should be able to express itself in the form of 'Mendelian characters'
(2) it should be able to generate its replica
(3) it should be unstable structurally and chemically
(4) it should provide the scope for slow changes that are required for evolution.

NEET-II 2016

83. The equivalent of a structural gene is
(1) muton
(2) cistron
(3) operon
(4) recon.

NEET-II 2016

84. Which of the following rRNAs acts as structural RNA as well as ribozyme in bacteria?
(1) 5S rRNA
(2) 18S rRNA
(3) 23S rRNA
(4) 5.8S rRNA

NEET-II 2016

85. DNA-dependent RNA polymerase catalyses transcription on one strand of the DNA which is called the
(1) template strand
(2) coding strand
(3) alpha strand
(4) antistrand.

NEET-I 2016

86. Which one of the following is the starter codon?
(1) UAA
(2) UAG
(3) AUG
(4) UGA

(2) 5'UACGUACGUACGUAC 3'
(3) 3' UACGUACGUACGUAC 5'
(4) 5' AUGCAUGCAUGCAUG 3'

Odisha NEET 2019

63. Match the following RNA polymerase with their transcribed products :

	Column I (RNA Polymerase)		Column II (Products)
1.	RNA polymerase I	(i)	tRNA
2.	RNA polymerase II	(ii)	rRNA
3.	RNA polymerase III	(iii)	hnRNA

Select the correct option from the following :
(1) 1-i, 2-iii, 3-ii
(2) 1-i, 2-ii, 3-iii
(3) 1-ii, 2-iii, 3-i
(4) 1-iii, 2-ii, 3-i

2019

64. Under which of the following conditions there will be no change in the reading frame of following mRNA?
5' AACAGCGGUGCUAUU 3'
(1) Deletion of GGU from 7th, 8th and 9th positions
(2) Insertion of G at 5th position
(3) Deletion of G from 5th position
(4) Insertion of A and G at 4th and 5th position respectively

2019

65. Which of the following features of genetic code does allow bacteria to produce human insulin by recombinant DNA technology?
(1) Genetic code is specific.
(2) Genetic code is not ambiguous.
(3) Genetic code is redundant.
(4) Genetic code is nearly universal.

2019

66. Match the following genes of the Lac operon with their respective products.

	Column I		Column II
A.	i gene	(i)	β-galactosidase
B.	z gene	(ii)	Permease
C.	a gene	(iii)	Repressor
D.	y gene	(iv)	Transacetylase

Select the correct option.
(1) (A)-(iii); (B)-(iv); (C)-(i); (D)-(ii)
(2) (A)-(i); (B)-(iii); (C)-(ii); (D)-(iv)
(3) (A)-(iii); (B)-(i); (C)-(ii); (D)-(iv)
(4) (A)-(iii); (B)-(i); (C)-(iv); (D)-(ii)

2019

67. Expressed Sequence Tags (ESTs) refers to
(1) novel DNA sequences
(2) genes expressed as RNA
(3) polypeptide expression
(4) DNA polymorphism.

2018

68. The experimental proof for semi-conservative replication of DNA was first shown in a
(1) fungus
(2) bacterium
(3) plant
(4) virus.

2018

69. Select the correct match.
(1) Ribozyme - Nucleic acid
(2) F_2 × Recessive parent - Dihybrid cross
(3) T.H. Morgan - Transduction
(4) G. Mendel - Transformation

2018

70. Select the correct statement.
(1) Franklin Stahl coined the term "linkage".
(2) Punnett square was developed by a British scientist.
(3) Spliceosomes take part in translation.
(4) Transduction was discovered by S. Altman.

2018

71. AGGTATCGCAT is a sequence from the coding strand of a gene. What will be the corresponding sequence of the transcribed mRNA?
(1) AGGUAUCGCAU
(2) UGGTUTCGCAT
(3) ACCUAUGCGAU
(4) UCCAUAGCGUA

2018

72. Many ribosomes may associate with a single mRNA to form multiple copies of a polypeptide simultaneously. Such strings of ribosomes are termed as
(1) polysome
(2) polyhedral bodies
(3) plastidome
(4) nucleosome.

2018

73. Select the correct match.
(1) Alec Jeffreys - Streptococcus pneumoniae
(2) Alfred Hershey and Martha Chase - TMV

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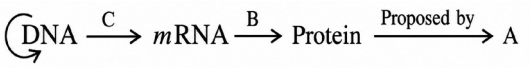
(2) A - Translation, B - Extension, C - Rosalind Franklin
(3) A - Transcription, B - Replication, C - James Watson
(4) A - Translation, B - Transcription, C - Ervin Chargaff

Karnataka NEET 2013

99. The figure gives an important concept in the genetic implication of DNA. Fill the blanks A, B and C.



(1) A-Maurice Wilkins, B-Transcription, C-Translation
(2) A-James Watson, B-Replication, C-Extension
(3) A-Erwin Chargaff, B-Translation, C-Replication
(4) A-Francis Crick, B-Translation, C-Transcription

Karnataka NEET 2013

100. Which of the following is not a property of the genetic code?
(1) Non-overlapping
(2) Ambiguous
(3) Degeneracy
(4) Universal

2013

101. Which enzyme will be produced in a cell if there is a nonsense mutation in the lac Y gene?
(1) Transacetylase
(2) Lactose permease and transacetylase
(3) β-galactosidase
(4) Lactose permease

Karnataka NEET 2013

102. In an inducible operon, the genes are
(1) usually not expressed unless a signal turns them "on".
(2) usually expressed unless a signal turns them "off".
(3) never expressed
(4) always expresser.

Karnataka NEET 2013

103. One of the most frequently used techniques in DNA fingerprinting is
(1) VNTR
(2) SSCP
(3) SCAR
(4) AFLP.

2012, 2009

104. Removal of introns and joining of exons in a defined order during transcription is called
(1) looping
(2) inducing
(3) slicing
(4) splicing.

2012

105. If one strand of DNA has the nitrogenous base sequence as ATCTG, what would be the complementary RNA strand sequence?
(1) TTAGU
(2) UAGAC
(3) AACTG
(4) ATCGU

2012

106. Ribosomal RNA is actively synthesised in
(1) lysosomes
(2) nucleolus
(3) nucleoplasm
(4) ribosomes.

2012

107. Which one of the following is not a part of a transcription unit in DNA?
(1) The inducer
(2) A terminator
(3) A promoter
(4) The structural gene

2012

108. Removal of RNA polymerase III from nucleoplasm will affect the synthesis of
(1) tRNA
(2) hnRNA
(3) mRNA
(4) rRNA.

Mains 2012

109. DNA fingerprinting refer to
(1) molecular analysis of profiles of DNA samples
(2) analysis of DNA samples using imprinting devices
(3) techniques used for molecular analysis of different specimens of DNA
(4) techniques used for identification of fingerprints of individuals.

2011

110. What are the structures called that give an appearance as 'beads-on-string' in the chromosomes when viewed under electron microscope?

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2005

136. During transcription holoenzyme RNA polymerase binds to a DNA sequence and the DNA assumes a saddle like structure at that point. What is that sequence called?
(1) AAAT box
(2) TATA box
(3) GGTT box
(4) CAAT box

2005

137. Using imprints from a plate with complete medium and carrying bacterial colonies, you can select streptomycin resistant mutants and prove that such mutations do not originate as adaptation. These imprints need to be used
(1) on plates with and without streptomycin
(2) on plates with minimal medium
(3) only on plates with streptomycin
(4) only on plates without streptomycin.

2005

138. *E.coli* cells with a mutated z gene of the lac operon cannot grow in medium containing only lactose as the source of energy because
(1) the lac operon is constitutively active in these cells
(2) they cannot synthesise functional beta galactosidase
(3) in the presence of glucose, E.coli cells do not utilise lactose
(4) they cannot transport lactose from the medium into the cell.

2004

139. The following ratio is generally constant for a given species:
(1) A + G / C + T
(2) T + C / G + A
(3) G + C / A + T
(4) A + C / T + G.

2004

140. During replication of a bacterial chromosome DNA synthesis starts from a replication origin site and
(1) RNA primers are involved
(2) is facilitated by telomerase
(3) moves in one direction of the site
(4) moves in bidirectional way.

2004

141. Which form of RNA has a structure resembling clover leaf?
(1) rRNA (2) hnRNA
(3) mRNA (4) tRNA

2004

142. During transcription, if the nucleotide sequence of the DNA strand that is being coded is ATACG then the nucleotide sequence in the mRNA would be
(1) TATGC
(2) TCTGG
(3) UAUGC
(4) UATGC.

NODIA

2004

143. After a mutation at a genetic locus the character of an organism changes due to change in
(1) protein structure
(2) DNA replication
(3) protein synthesis pattern
(4) RNA transcription pattern.

2004

144. In mutational event, when adenine is replaced by guanine, it is a case of
(1) frame shift mutation
(2) transcription
(3) transition
(4) transversion.

2004

145. What is it that forms the basis of DNA fingerprinting?
(1) The relative proportions of purines and pyrimidines in DNA.
(2) The relative difference in the DNA occurrence in blood, skin and saliva.
(3) The relative amount of DNA in the ridges and grooves of the fingerprints.
(4) Satellite DNA occurring as highly repeated short DNA segments.

2003

146. During transcription, the DNA site at which RNA polymerase binds is
(1) promoter
(2) regulator
(3) receptor
(4) enhancer.

2003

147. What would happen if in a gene encoding a polypeptide of 50 amino acids, 25th codon (UAU) is mutated to UAA ?
(1) A polypeptide of 24 amino acids will be formed.
(2) Two polypeptides of 24 and 25 amino acids will be formed.
(3) A polypeptide of 49 amino acids will be formed.

2008

123. In the DNA molecule,
(1) the proportion of adenine in relation to thymine varies with the organism
(2) there are two strands which run anti-parallel-one in 5' → 3' direction and other in 3' → 5'
(3) the total amount of purine nucleotides and pyrimidine nucleotides is not always equal
(4) there are two strands which run parallel in the 5' → 3' direction.

2008

124. Which one of the following pairs of nitrogenous bases of nucleic acids, is wrongly matched with the category mentioned against it?
(1) Guanine, Adenine - Purines
(2) Adenine, Thymine - Purines
(3) Thymine, Uracil - Pyrimidines
(4) Uracil, Cytosine - Pyrimidines

2008

125. Which one of the following pairs of codons is correctly matched with their function or the signal for the particular amino acid?
(1) AUG, ACG - Start/methionine
(2) UUA, UCA - Leucine
(3) GUU, GCU - Alanine
(4) UAG, UGA - Stop

2008

126. Polysome is formed by
(1) a ribosome with several subunits
(2) ribosomes attached to each other in a linear arrangement
(3) several ribosomes attached to a single mRNA
(4) many ribosomes attached to a strand of endoplasmic reticulum.

2008

127. The two sub-units of ribosome remain united at a critical ion level of
(1) magnesium
(2) calcium
(3) copper
(4) manganese.

2006

128. One turn of the helix in a B-form DNA is approximately
(1) 2 nm
(2) 20 nm
(3) 0.34 nm
(4) 3.4 nm.

2006

129. Antiparallel strands of a DNA molecule means that
(1) one strand turns clockwise
(2) one strand turns anti-clockwise
(3) the phosphate groups of two DNA strands, at their ends, share the same position
(4) the phosphate groups at the start of two DNA strands are in opposite position (pole).

2006

130. One gene-one enzyme hypothesis was postulated by
(1) Beadle and Tatum
(2) R. Franklin
(3) Hershey and Chase
(4) A. Garrod.

2006

131. Which antibiotic inhibits interaction between tRNA and mRNA during bacterial protein synthesis?
(1) Tetracycline
(2) Erythromycin
(3) Neomycin
(4) Streptomycin

2006

132. Amino acid sequence, in protein synthesis is decided by the sequence of
(1) rRNA (2) tRNA
(3) mRNA (4) cDNA.

2005

133. Which one of the following makes use of RNA template to synthesise DNA?
(1) DNA polymerase
(2) RNA polymerase
(3) Reverse transcriptase
(4) DNA dependant RNA polymerase

2005

134. Which one of the following hydrolyses internal phosphodiester bonds in a polynucleotide chain?
(1) Lipase
(2) Protease
(3) Endonuclease
(4) Exonuclease

2005

135. Telomerase is an enzyme which is a
(1) simple protein
(2) RNA
(3) ribonucleoprotein
(4) repetitive DNA.

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1996

190. Which of the following serves as a terminal codon?
(1) UAG
(2) AGA
(3) AUG
(4) GCG

1995

191. If the sequence of bases in DNA is ATTCGATG, then the sequence of bases in its transcript will be
(1) GUAGCUUA
(2) AUUCGAUG
(3) CAUCGAAU
(4) UAAGCUAC.

1995

192. In split genes, the coding sequences are called
(1) exons (2) cistrons
(3) introns (4) operons.

1995

193. If the DNA codons are ATG ATG ATG and a cytosine base is inserted at the beginning, then which of the following will result?
(1) CAT GAT GAT G
(2) A non-sense mutation
(3) C ATG ATG ATG
(4) CA TGA TGA TG

1995

194. Anticodon is an unpaired triplet of bases in an exposed position of
(1) tRNA
(2) mRNA
(3) rRNA
(4) both (2) and (3).

1995

195. The wild type E.coli cells are growing in normal medium with glucose. They are transferred to a medium containing only lactose as sugar. Which of the following changes take place?
(1) The lac operon is induced.
(2) E.coli cells stop dividing.
(3) The lac operon is repressed.
(4) All operons are induced.

1995

196. The lac operon is an example of
(1) repressible operon
(2) overlapping genes
(3) arabinose operon
(4) inducible operon.

1995

197. An environmental agent, which triggers transcription from an operon, is a
(1) depressor
(2) controlling element
(3) regulator
(4) inducer.

1994

198. There are special proteins that help to open up DNA double helix in front of the replication fork. These proteins are
(1) DNA ligase
(2) DNA topoisomerase I
(3) DNA gyrase
(4) DNA polymerase I.

1994

199. In protein synthesis, the polymerisation of amino acids involves three steps. Which one of the following is not involved in the polymerisation of protein ?
(1) Termination
(2) Initiation
(3) Elongation
(4) Transcription

1994

200. 'Lac operon' in E. coli, is induced by
(1) 'i' gene
(2) promoter gene
(3) β-galactosidase
(4) lactose.

1993

201. Nucleosome core is made of
(1) H_0, H_2A, H_2B and H3
(2) H_1, H_2A, H_2B, H_4
(3) H_1, H_2A, H_2B, H_3 and H_4
(4) H_2A, H_2B, H_3 and H_4.

1993

202. A DNA with unequal nitrogen bases would most probably be
(1) single stranded
(2) double stranded
(3) triple stranded
(4) four stranded.

1993

203. Nucleotide arrangement in DNA can be seen by
(1) X-ray crystallography
(2) electron microscope
(3) ultracentrifuge
(4) light microscope.

NODIA

(4) A polypeptide of 25 amino acids will be formed.

2003

148. Which one of the following triplet codes, is correctly matched with its specificity for an amino acid in protein synthesis or as 'start' or 'stop' codon?
(1) UCG - Start
(2) UUU - Stop
(3) UGU - Leucine
(4) UAC - Tyrosine

2003

149. Degeneration of a genetic code is attributed to the
(1) first member of a codon
(2) second member of codon
(3) entire codon
(4) third member of a codon.

2003

150. In the genetic code dictionary, how many codons are used to code for all the 20 essential amino acids ?
(1) 20
(2) 64
(3) 61
(4) 60

2003

151. During translation initiation in prokaryotes, a GTP molecule is needed in
(1) formation of formyl-met-tRNA
(2) binding of 30S subunit of ribosome with mRNA
(3) association of 30S mRNA with formyl-met-tRNA
(4) association of 50S subunit of ribosome with initiation complex.

2003

152. What does "lac" refer to in what we call the lac operon ?
(1) Lactose
(2) Lactase
(3) Lac insect
(4) The number 1,00,000

2002

153. In a DNA percentage of thymine is 20% then what will be percentage of guanine?
(1) 20%
(2) 40%
(3) 30%
(4) 60%

2002

154. Transformation experiment was first performed on which bacteria?
(1) E. coli
(2) Diplococcus pneumoniae
(3) Salmonella
(4) Pasteurella pestis

2002

155. Which of the following reunites the exon segments after RNA splicing?
(1) RNA polymerase
(2) RNA primase
(3) RNA ligase
(4) RNA proteoses

2002

156. Exon part of mRNAs have code for
(1) protein
(2) lipid
(3) carbohydrate
(4) phospholipid.

2002

157. Out of 64 codons, 61 codons code for 20 types of amino acid. It is called
(1) degeneracy of genetic code
(2) overlapping of gene
(3) wobbling of codon
(4) universility of codons.

2002

158. Change in sequence of nucleotide in DNA is called
(1) mutagen (2) mutation
(3) recombination (4) translation.

2002

159. Protein synthesis in an animal cell occurs
(1) only on the ribosomes present in cytosol
(2) only on ribosome attached to the nuclear envelope and endoplasmic reticulum
(3) on ribosome present in the nucleolus as well as in cytoplasm
(4) on ribosomes present in cytoplasm as well as in mitochondria.

2002

160. Jacob and Monod studied lactose metabolism in E. coli and proposed operon concept. Operon concept is applicable for
(1) all prokaryotes
(2) all prokaryotes and some eukaryotes
(3) all prokaryotes and all eukaryotes
(4) all prokaryotes and some protozoans.

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2002

161. In E. coli, during lactose metabolism repressor binds to
(1) regulator gene
(2) operator gene
(3) structural gene
(4) promoter gene.

2001

162. mRNA is synthesised on DNA template in which direction?
(1) 5' → 3'
(2) 3' → 5'
(3) Both (1) and (2)
(4) Any

2001

163. Gene and cistron words are sometimes used synonymously because
(1) one cistron contains many genes
(2) one gene contains many cistrons
(3) one gene contains one cistron
(4) one gene contains no cistron.

2001

164. Types of RNA polymerase required in nucleus of eukaryotes for RNA synthesis
(1) 1 (2) 2
(3) 3 (4) 4.

2001

165. In negative operon,
(1) co-repressor binds with repressor
(2) co-repressor does not bind with repressor
(3) co-repressor binds with inducer
(4) cAMP have negative effect on lac operon.

2000

166. Length of one loop of B-DNA
(1) 3.4 nm
(2) 0.34 nm
(3) 20 nm
(4) 10 nm.

2000

167. Similarity in DNA and RNA is that
(1) both are polymer of nucleotides
(2) both have similar pyrimidine
(3) both have similar sugar
(4) both are genetic material.

2000

168. Method of DNA replication in which two strands of DNA separate and synthesise new strands is called
(1) dispersive
(2) conservative
(3) semi-conservative
(4) non conservative.

2000

169. Anticodon occurs in
(1) tRNA
(2) mRNA
(3) rRNA
(4) DNA.

2000

170. In three dimensional view the molecule of tRNA is
(1) L-shaped
(2) S-shaped
(3) Y-shaped
(4) E-shaped.

2000

171. Which of the following is initiation codon?
(1) UAG (2) AUC
(3) AUG (4) CCU

1999

172. DNA is mainly found in
(1) nucleolus
(2) nucleus only
(3) cytoplasm only
(4) none of these.

1999

173. In prokaryotes, the genetic material is
(1) linear DNA without histones
(2) circular DNA without histones
(3) linear DNA with histones
(4) circular DNA with histones.

1999

174. In DNA, when AGCT occurs, their association is as per which of the following pair?
(1) AT-GC
(2) AG-CT
(3) AC-GT
(4) All of these

1999

175. The eukaryotic genome differs from the prokaryotic genome because
(1) the DNA is complexed with histone in prokaryotes
(2) the DNA is circular and single stranded in prokaryotes
(3) repetitive sequences are present in eukaryotes
(4) genes in the former case are organised into operons.

NODIA

1999

176. The Pneumococcus experiment proves that
(1) bacteria do not reproduce sexually
(2) RNA sometime controls the production of DNA and proteins
(3) DNA is the genetic material
(4) bacteria undergo binary fission.

1999

177. Initiation codon in eukaryotes is
(1) GAU
(2) AGU
(3) AUG
(4) UAG.

1999

178. In operon concept, regulator gene functions as
(1) inhibitor
(2) repressor
(3) regulator
(4) all of these.

1998

179. Genes that are involved in turning on or off the transcription of a set of structural genes are called
(1) redundant genes
(2) regulatory genes
(3) polymorphic genes
(4) operator genes.

1998

180. DNA elements, which can switch their position, are called
(1) cistrons
(2) transposons
(3) exons
(4) introns.

1998

181. What base is responsible for hotspots for spontaneous point mutations?
(1) 5-bromouracil
(2) 5-methylcytosine
(3) Guanine
(4) Adenine

1997

182. Genes are packaged into a bacterial chromosome by
(1) acidic protein
(2) actin
(3) histones
(4) basic protein.

1997

183. DNA synthesis can be specifically measured by estimating the incorporation of radio-labelled
(1) thymidine
(2) deoxyribose sugar
(3) uracil
(4) adenine.

1997

184. The codons causing chain termination are
(1) AGT, TAG, UGA
(2) UAG, UGA, UAA
(3) TAG, TAA, TGA
(4) GAT, AAT, AGT.

1997

185. The RNA that pick up specific amino acid from amino acid pool in the cytoplasm to ribosome during protein synthesis is called
(1) rRNA
(2) RNA
(3) mRNA
(4) tRNA.

1997

186. Which of the following step of translation does not consume a high energy phosphate bond?
(1) Peptidyl transferase reaction
(2) Aminoacyl tRNA binding to A-site
(3) Translocation
(4) Amino acid activation

1997

187. Protein synthesis in an animal cell, takes place
(1) in the cytoplasm as well as endoplasmic reticulum
(2) only on ribose attached to nucleon
(3) only in the cytoplasm
(4) in the nucleolus as well as in the cytoplasm.

1996

188. Radiotracer technique shows that DNA is in
(1) multi-helix stage
(2) single-helix stage
(3) double-helix stage
(4) none of these.

1996

189. The maximum formation of mRNA occurs in
(1) ribosome
(2) nucleoplasm
(3) cytoplasm
(4) nucleolus.

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ANSWERS

1. (3) Gene i is constitutively expressed
The regulatory gene i is constitutively expressed, producing the repressor protein. Genes z, y and a share a promoter, but i has its own (1 wrong). The natural inducer is allolactose, not galactose (2 wrong), and lactose inactivates the repressor (4 wrong).

2. (4) RNA polymerase II
In eukaryotes, RNA polymerase II transcribes the precursor of mRNA (heterogeneous nuclear RNA, hnRNA). RNA polymerase I transcribes rRNAs and RNA polymerase III transcribes tRNA and small RNAs.

3. (3) beta-galactosidase
The lac operon has three structural genes: z, y, and a. The z gene codes for beta-galactosidase, which hydrolyses lactose into glucose and galactose. The y gene codes for permease, and the a gene codes for transacetylase. The repressor is coded by the i gene.

4. (4) A, B, C, D and E
A transcription unit comprises a promoter, structural gene and terminator. The promoter lies at the 5'-end, provides the RNA polymerase binding site, and defines the template and coding strands. The terminator lies at the 3'-end and ends transcription. Hence all statements A to E are correct.

5. (1) A, C and E only
Histones form an octamer of eight molecules (A correct), are rich in lysine and arginine (C correct), and higher-level packaging needs non-histone chromosomal proteins (E correct). Statements B and D are wrong because histones are positively charged and DNA is negatively charged.

6. (1) GUG
In sickle-cell anaemia, the sixth codon of the beta globin gene changes from GAG (glutamic acid) to GUG (valine). This single base substitution causes valine to replace glutamic acid, leading to polymerization of haemoglobin (HbS) and the characteristic sickle shape of red blood cells under low oxygen.

7. (3) lysine and arginine
Histones are a set of positively charged, basic proteins found in eukaryotic cell nuclei. These proteins are highly enriched in basic amino acid residues, specifically lysine and arginine. Both of these amino acids carry positive charges in their side chains, which allows them to bind tightly to the negatively charged phosphate backbone of the DNA molecule.

8. (1) A-IV, B-III, C-I, D-II
Alfred Hershey and Martha Chase provided confirmation that DNA is the genetic material. Euchromatin refers to loosely packed, transcriptionally active chromatin that stains lightly. Frederick Griffith discovered the transforming principle using Streptococcus pneumoniae. Heterochromatin is densely packed, transcriptionally inactive chromatin that stains dark. These biological concepts are fundamental to understanding molecular genetics and the structural organization of genomic information.

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9. (3) Both statement I and statement II are correct.
RNA is widely considered the first genetic material to evolve, serving as both a carrier of genetic information and a catalyst for biochemical reactions. Due to its reactive nature, RNA is relatively unstable. DNA subsequently evolved from RNA with structural modifications that enhanced chemical stability. Its double-helical structure and complementary strands allow for effective repair mechanisms and resistance to changes.

10. (4) B, C, D only
In eukaryotic cells, primary transcripts undergo several modifications before becoming functional messenger RNA. These include the removal of non-coding introns and the joining of coding exons through splicing. Additionally, a methyl guanosine triphosphate cap is added to the five-prime end, and a poly-adenine tail is attached to the three-prime end. These steps occur within the nucleus before transport.

1993

204. The transforming principle of Pneumococcus as found out by Avery, MacLeod and McCarty was
(1) mRNA
(2) DNA
(3) protein
(4) polysaccharide.

1993

205. Who proved that DNA is basic genetic material?
(1) Griffith
(2) Watson
(3) Boveri and Sutton
(4) Hershey and Chase

1993

206. During DNA replication, the strands separate by
(1) DNA polymerase
(2) topoisomerase
(3) unwindase/helicase
(4) gyrase.

1993

207. Initiation codon of protein synthesis (in eukaryotes) is
(1) GUA
(2) GCA
(3) CCA
(4) AUG.

1993

208. Because most of the amino acids are represented by more than one codon, the genetic code is
(1) overlapping
(2) wobbling
(3) degenerate
(4) generate.

1993

209. The process of translation is
(1) ribosome synthesis
(2) protein synthesis
(3) DNA synthesis
(4) RNA synthesis.

1992

210. Escherichia coli fully labelled with 15N is allowed to grow in 14N medium. The two strands of DNA molecule of the first generation bacteria have
(1) different density and do not resemble parent DNA
(2) different density but resemble parent DNA
(3) same density and resemble parent DNA
(4) same density but do not resemble parent DNA.

1992

211. Experimental material in the study of DNA replication has been
(1) Escherichia coli
(2) Neurospora crassa
(3) Pneumococcus
(4) Drosophila melanogaster.

1992

212. Khorana first deciphered the triplet codons of
(1) serine and isoleucine
(2) cysteine and valine
(3) tyrosine and tryptophan
(4) phenylalanine and methinonine.

1991

213. The process of transfer of genetic information from DNA to RNA/formation of RNA from DNA is
(1) transversion
(2) transcription
(3) translation
(4) translocation.

1990

214. An octamer of 4 histones complexed with DNA forms
(1) endosome
(2) nucleosome
(3) mesosome
(4) centromere.

1990

215. In the genetic dictionary, there are 64 codons as
(1) 64 amino acids are to be coded
(2) 64 types of tRNAs are present
(3) there are 44 nonsense codons and 20 sense codons
(4) genetic code is triplet.

1989

216. DNA replication is
(1) conservative and discontinuous
(2) semi-conservative and semi-discontinuous
(3) semi-conservative and discontinuous
(4) conservative.

1988

217. Genetic code consists of
(1) adenine and guanine
(2) cytosine and uracil
(3) cytosine and guanine
(4) all of these.

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(1) Genes
(2) Nucleotides
(3) Nucleosomes
(4) Base pairs

Mains 2011

111. The unequivocal proof of DNA as the genetic material came from the studies on a
(1) bacterium
(2) fungus
(3) viroid
(4) bacterial virus.

2011

112. Which one of the following also acts as a catalyst in a bacterial cell?
(1) 5S rRNA
(2) snRNA
(3) hnRNA
(4) 23S rRNA

2010

113. Which one of the following does not follow the central dogma of molecular biology?
(1) Pea
(2) Mucor
(3) Chlamydomonas
(4) HIV

Mains 2010

114. The 3' - 5' phosphodiester linkages inside a polynucleotide chain serve to join
(1) one DNA strand with the other DNA strand
(2) one nucleoside with another nucleoside
(3) one nucleotide with another nucleotide
(4) one nitrogenous base with pentose sugar.

2010

115. Which one of the following statements about the particular entity is true ?
(1) Centromere is found in animal cells, which produces aster during cell division.
(2) The gene for producing insulin is present in every body cell.
(3) Nucleosome is formed of nucleotides.
(4) DNA consists of core of eight histones.

Main 2010

116. In eukaryotic cell transcription, RNA splicing and RNA capping take place inside the
(1) ribosomes
(2) nucleus
(3) dictyosomes
(4) ER.

2010

117. The one aspect which is not a salient feature of genetic code, is its being
(1) degenerate (2) ambiguous
(3) universal (4) specific.

2010

118. Select the two correct statements out of the four (i - iv) statements given below about lac operon.
(i) Glucose or galactose may bind with the repressor and inactivate it.
(ii) In the absence of lactose, the repressor binds with the operator region.
(iii) The z-gene codes for permease.
(iv) This was elucidated by Francois Jacob and Jacques Monod.
The correct statements are
(1) (ii) and (iii)
(2) (i) and (iii)
(3) (ii) and (iv)
(4) (i) and (ii).

Mains 2010

119. The lac operon consists of
(1) four regulatory genes only
(2) one regulatory gene and three structural genes
(3) two regulatory genes and two structural genes
(4) three regulatory genes and three structural genes.

2009

120. Semi-conservative replication of DNA was first demonstrated in
(1) Escherichia coli
(2) Streptococcus pneumoniae
(3) Salmonella typhimurium
(4) Drosophila melanogaster.

2009

121. Whose experiments cracked the DNA and discovered unequivocally that a genetic code is a "triplet"?
(1) Hershey and Chase
(2) Morgan and Sturtevant
(3) Beadle and Tatum
(4) Nirenberg and Mathaei

2009

122. What is not true for genetic code?
(1) It is nearly universal.
(2) It is degenerate.
(3) It is unambiguous.
(4) A codon in mRNA is read in a non-contiguous fashion.

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11. (1) ρ (rho)
In prokaryotic transcription, the termination process requires a specific protein known as the rho factor. This factor binds to the growing RNA chain and moves toward the RNA polymerase. Once it reaches the transcription complex, it facilitates the release of the newly synthesized RNA molecule and the dissociation of the enzyme from the DNA template, effectively ending the process.

12. (3) George Gamow
George Gamow, a physicist, argued that since there are only four bases to code for twenty amino acids, the genetic code must involve combinations of nucleotides. He proposed that a triplet code, consisting of three bases per codon, would provide sixty-four possible combinations. This was more than enough to specify all essential amino acids required for protein synthesis in living organisms.

13. (1) Chromosome 1
The Human Genome Project revealed significant differences in gene distribution across various chromosomes. Chromosome 1 is the largest human chromosome and contains the highest number of genes, totaling approximately 2,968. In contrast, the Y chromosome is the smallest and has the fewest genes. Mapping these gene sequences was a crucial achievement in understanding the genetic blueprint of human beings.

14. (4) They are fraternal twins.
Fraternal twins, also known as dizygotic twins, result from the fertilization of two separate eggs by two different sperm cells during the same pregnancy. Because they originate from different zygotes, they can be of different sexes and are genetically as similar as ordinary siblings. Monozygotic twins, however, always share the same sex because they originate from a single zygote.

15. (4) A-III, B-IV, C-I, D-II
Histones are basic proteins that carry a positive charge, allowing them to interact with negatively charged DNA. A nucleosome is formed when DNA wraps around a histone octamer. Euchromatin represents loosely packed, transcriptionally active regions of the genome. Conversely, heterochromatin consists of densely packed, transcriptionally inactive DNA. These structural variations are essential for regulating gene expression and chromosomal organization.

16. (4) The DNA dependent DNA polymerase catalyses polymerisation in 5' → 3' direction.
DNA replication in Escherichia coli is a highly accurate process catalyzed by DNA-dependent DNA polymerase. This enzyme can only add new nucleotides to the three-prime hydroxyl group of a growing DNA strand. Consequently, the synthesis of new DNA always proceeds in the five-prime to three-prime direction. This directional constraint results in continuous synthesis on the leading strand and discontinuous synthesis on the lagging strand.

17. (1) Statement I is true but statement II is false.
In prokaryotic organisms, a single DNA-dependent RNA polymerase is responsible for the synthesis of all types of RNA. While the enzyme itself can catalyze the elongation phase of transcription, it requires specific factors for initiation and termination. The sigma factor is needed to start the process at the promoter, while the rho factor is required to terminate the transcription process.

18. (3) Both statement I and statement II are correct.
Eukaryotic cells possess a more complex transcriptional machinery compared to prokaryotes. The nucleus contains three distinct RNA polymerases, each responsible for transcribing different classes of genes. RNA polymerase one transcribes ribosomal RNAs, while RNA polymerase two synthesizes messenger RNA precursors. RNA polymerase three is responsible for transfer RNA and other small RNAs. Additionally, separate RNA polymerases function within mitochondria and chloroplasts.

19. (1) 5'AUGUACCGUUUAUAGGUAAGU 3'
During transcription, RNA is synthesized using a DNA template strand. The enzyme RNA polymerase reads the template in the three-prime to five-prime direction and assembles a complementary RNA strand in the five-prime to three-prime direction. In this process, adenine pairs with uracil instead of thymine. Therefore, the DNA sequence provided yields a complementary messenger RNA sequence with the correct base orientation.

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to demonstrate that when a virus infects a bacterium, only the viral DNA enters the host cell. This established DNA, not protein, as the actual genetic material.

77. (3) the lagging strand away from the replication fork
DNA replication is an asymmetrical process because DNA polymerase can only synthesize in the five-prime to three-prime direction. While the leading strand is synthesized continuously toward the replication fork, the lagging strand is synthesized in short segments known as Okazaki fragments. These fragments are synthesized in a direction that moves away from the replication fork and are later joined by DNA ligase.

78. (4) rRNA
Eukaryotic cells contain several types of RNA, each serving a distinct purpose in the cell. Ribosomal RNA is the most abundant type, often making up about eighty percent of the total RNA in an animal cell. This is because it forms the structural and functional core of ribosomes, the protein-making factories of the cell, which are required in large numbers for growth.

79. (3) bacteria
Splicing is a critical step in the processing of primary RNA transcripts in eukaryotic organisms, such as fungi, plants, and animals. It involves the removal of non-coding introns and the joining of coding exons by a complex called the spliceosome. Prokaryotic organisms, like bacteria, generally lack introns in their structural genes and therefore do not require spliceosomes for RNA processing.

80. (2) 33
The genetic code is read in non-overlapping triplets called codons. If a single base is deleted at position nine hundred and one, every codon following that point will be shifted. Since there are ninety-nine bases remaining from that point to the end of the original nine hundred ninety-nine base sequence, and each codon has three bases, thirty-three subsequent codons will be altered.

81. (2) Vicia faba
While Meselson and Stahl proved semi-conservative DNA replication in bacteria, Herbert Taylor and his colleagues conducted similar research on eukaryotic chromosomes. In nineteen fifty-eight, they used radioactive thymidine to track chromosome replication in the root tip cells of the faba bean, Vicia faba. Their findings confirmed that the semi-conservative model of replication also applies to the complex chromosomes of multicellular eukaryotic organisms.

82. (3) it should be unstable structurally and chemically
For a molecule to function as the genetic material, it must possess several key properties. It must be able to replicate itself accurately, remain chemically and structurally stable, and provide the potential for slow mutations necessary for evolution. A molecule that is inherently unstable would not be suitable for storing genetic information over long periods or across generations of living organisms.

83. (2) cistron
The term cistron is often used in molecular biology to refer to a segment of DNA that encodes a single functional polypeptide chain. In this context, it is considered the modern functional equivalent of a structural gene. While other terms like muton and recon refer to units of mutation and recombination respectively, cistron specifically identifies the unit of genetic information that yields a protein.

84. (3) 23S rRNA
In bacteria, the ribosome contains several ribosomal RNA molecules that serve both structural and functional roles. The twenty-three S ribosomal RNA is a critical component of the large ribosomal subunit. It not only provides structural support but also acts as a ribozyme. Specifically, it catalyzes the formation of peptide bonds between amino acids during the process of protein synthesis, or translation.

85. (1) template strand
During transcription, the enzyme DNA-dependent RNA polymerase reads only one of the two DNA strands to synthesize a complementary RNA molecule. The strand that is used as the physical guide for RNA assembly is known as the template strand. It is read in the three-prime to five-prime direction, resulting in an RNA molecule synthesized in the five-prime to three-prime direction.

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Their nineteen fifty-two experiment used radioactive isotopes to track the components of bacteriophages during infection. They showed that the viral DNA, not the protein, entered the host bacteria, confirming that DNA carries the information for reproduction.

30. (3) Both statement I and statement II are true.
RNA serves as an essential intermediary in the expression of genetic information. Because it is chemically reactive and structurally less stable than DNA, it tends to mutate at a faster rate. Furthermore, RNA can directly code for the synthesis of proteins, which allows for the straightforward expression of biological characters. These properties were particularly important in the early stages of life's evolution.

31. (3) Both statement I and statement II are true.
Transcription is the fundamental biological process where genetic information from one strand of DNA is copied into a complementary RNA molecule. A typical transcription unit within the DNA is defined by three specific regions. These include the promoter, which initiates the process; the structural gene, which contains the coding sequence; and the terminator, which signals the completion of the RNA synthesis.

32. (4) Transcription of tRNA, 5 SrRNA and snRNA
In eukaryotic organisms, the transcription process is managed by three distinct types of RNA polymerase enzymes. RNA polymerase three is specifically responsible for the synthesis of transfer RNAs, the five-S fraction of ribosomal RNA, and various small nuclear RNAs. Each polymerase has a specialized role, ensuring that the diverse types of RNA required for cellular function are accurately and efficiently produced.

33. (1) 5' ATCGATCGATCGATCGATCGATCGATCG 3'
The coding strand of DNA has the same sequence as the resulting messenger RNA, except that thymine is present in DNA instead of uracil in RNA. Both the coding strand and the messenger RNA are oriented in the five-prime to three-prime direction. Therefore, to find the coding sequence, one simply replaces all uracil bases in the RNA sequence with thymine bases.

34. (4) (C) and (D) only
The genetic code possesses several essential characteristics that ensure accurate protein synthesis. It is unambiguous and specific, meaning that each individual codon codes for only one particular amino acid. Furthermore, the code is nearly universal, as the same codons generally specify the same amino acids across almost all known organisms. These features are fundamental to the conservation of genetic information.

35. (4) (A) and (C) only
Sickle cell anemia is a classic example of a genetic disorder caused by a point mutation in the gene encoding the beta-globin chain of hemoglobin. This mutation involves a single base substitution where the codon GAG is changed to GUG. Consequently, the amino acid glutamic acid is replaced by valine at the sixth position of the protein, altering the hemoglobin structure.

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36. (2) Lactose
In the lac operon system of Escherichia coli, the expression of genes required for lactose metabolism is regulated by the presence of an inducer. Lactose itself, or its isomer allolactose, serves as this inducer molecule. It binds to the repressor protein, causing it to change shape and detach from the operator region, thereby allowing RNA polymerase to begin the transcription process.

37. (3) Repressor protein
The regulation of an operon involves a specific protein called a repressor, which is produced by a regulatory gene. This repressor protein has a high affinity for the operator region of the operon. When the repressor binds to the operator, it physically blocks RNA polymerase from moving along the DNA. This prevents the transcription of structural genes when the product is unnecessary.

38. (4) A-II, B-III, C-IV, D-I
The lac operon consists of regulatory and structural genes that coordinate lactose metabolism. The i-gene produces a repressor protein that inhibits transcription. The z-gene encodes beta-galactosidase for breaking down lactose. The y-gene produces permease to facilitate lactose entry into the cell. Finally, the a-gene codes for transacetylase. Together, these

20. (4) A-IV, B-III, C-I, D-II
In eukaryotes, RNA polymerase three is responsible for transcribing transfer RNA and five-S ribosomal RNA. The termination of transcription in bacteria often involves the rho factor. Splicing, which removes introns from primary transcripts, is carried out by small nuclear ribonucleoproteins. The TATA box is a conserved DNA sequence found within the promoter region that helps position the RNA polymerase correctly.

21. (4) promotor, structural gene, terminator.
A transcription unit in DNA consists of three primary regions that facilitate the synthesis of RNA. The promoter is located upstream and provides the binding site for RNA polymerase to initiate the process. The structural gene contains the actual genetic information to be transcribed. Finally, the terminator is located downstream and signals the end of the transcription process for the enzyme.

22. (1) Statement I is true but statement II is false.
The lac operon is a classic example of gene regulation in bacteria. The z-gene encodes the enzyme beta-galactosidase, which breaks down lactose into its constituent sugars, glucose and galactose. Lactose acts as the inducer by binding to the repressor protein. However, glucose and galactose themselves do not act as inducers; in fact, the presence of glucose typically suppresses the operon.

23. (3) permease
For Escherichia coli to utilize lactose, the sugar must first enter the bacterial cell from the surrounding growth medium. This transport process is facilitated by the enzyme permease, which is encoded by the y-gene of the lac operon. Permease increases the cell's permeability to beta-galactosides. Without functional permease, the bacteria cannot effectively take up lactose, even if the sugar is present.

24. (2) A-III, B-IV, C-I, D-II
Frederick Griffith discovered the process of transformation in bacteria. Francois Jacob and Jacques Monod elucidated the mechanism of the lac operon for gene regulation. Har Gobind Khorana played a vital role in deciphering the genetic code through chemical synthesis of RNA. Matthew Meselson and Franklin Stahl provided experimental evidence for the semi-conservative nature of DNA replication using heavy nitrogen isotopes.

25. (2) Statement I incorrect but Statement II is true.
In prokaryotic cells, the DNA is not contained within a nucleus but is organized into a region called the nucleoid. Here, the negatively charged DNA is held together by some positively charged proteins. In eukaryotes, the organization is more complex, where the negatively charged DNA is wrapped around a positively charged histone octamer to form repeating units called nucleosomes in chromatin.

26. (2) (A) and (B) only
Alfred Hershey and Martha Chase used radioactive isotopes to distinguish between viral DNA and protein. Bacteriophages grown in radioactive phosphorus incorporated the label into their DNA, as phosphorus is a key component of nucleic acids. Conversely, viruses grown in radioactive sulfur incorporated the label into their protein coats, as sulfur is found in certain amino acids but not in DNA.

27. (2) A.D Hershey and M.J. Chase
The definitive proof that DNA is the genetic material was provided by Alfred Hershey and Martha Chase in nineteen fifty-two. They conducted experiments using bacteriophages, which are viruses that infect bacteria. By selectively labeling the viral DNA with radioactive phosphorus and the protein coat with radioactive sulfur, they demonstrated that only the DNA enters the bacterial cell to direct viral replication.

28. (3) Both Statement I and Statement II are true.
RNA is chemically more reactive and less stable than DNA, primarily due to the presence of a two-prime hydroxyl group on its ribose sugar. This instability causes RNA to mutate at a significantly faster rate. Consequently, viruses that possess an RNA genome and have short life cycles exhibit rapid mutation and evolution, allowing them to adapt quickly to changing environmental conditions.

29. (4) Alfred Hershey and Martha Chase
While several scientists contributed to the understanding of genetic material, Alfred Hershey and Martha Chase provided the unequivocal proof that DNA serves this function.

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48. (4) (P)-Replication; (Q)-Transcription; (R)-Translation; (S)-Protein
The central dogma of molecular biology describes the sequential flow of genetic information within a biological system. It starts with the replication of DNA to maintain genetic information. This is followed by transcription, where DNA is used as a template to produce messenger RNA. Finally, the process of translation converts the information in the messenger RNA into a specific sequence of proteins.

49. (4) T : 30 ; G : 20 ; C : 20
According to Chargaff's rules for double-stranded DNA, the amount of adenine is always equal to thymine, and the amount of guanine is always equal to cytosine. If adenine is thirty percent, then thymine must also be thirty percent. This leaves forty percent for the guanine-cytosine pairs. Therefore, guanine and cytosine must each account for twenty percent of the total DNA base composition.

50. (3) The pH of histones is slightly acidic.
Histones are a family of basic proteins that play a crucial role in the structural organization of eukaryotic DNA. They are rich in basic amino acids like lysine and arginine, which give them a positive charge. This charge allows them to bind to acidic, negatively charged DNA. Because they are basic proteins, histones have a pH that is slightly alkaline rather than acidic.

51. (3) Transcribes tRNA, 5S rRNA and snRNA
Eukaryotic cells utilize specialized RNA polymerase enzymes for different transcriptional tasks. RNA polymerase three is particularly important for the synthesis of small RNA molecules. Its primary role includes the transcription of all transfer RNAs, which are essential for translation. Additionally, it is responsible for producing the five-S fraction of ribosomal RNA and several small nuclear RNAs involved in various cellular processes.

52. (3) RNA polymerase binds with Rho factor to terminate the process of transcription in bacteria.
Transcription in bacteria is a streamlined process compared to eukaryotes. To end the synthesis of an RNA molecule, the RNA polymerase enzyme must recognize a termination signal on the DNA template. In many cases, this requires the assistance of a specific protein known as the rho factor. The binding of the rho factor to the enzyme complex triggers the release of the RNA.

53. (3) DNA dependent RNA polymerase
In prokaryotic organisms like bacteria, a single enzyme known as DNA-dependent RNA polymerase is capable of performing all stages of transcription. This versatile enzyme manages the initiation of RNA synthesis at the promoter, the elongation of the RNA chain, and the eventual termination of the process. While it often works with auxiliary factors, the core enzyme remains the primary catalyst throughout transcription.

54. (1) Statement I is incorrect but Statement II is true.
The genetic code is nearly universal and highly specific. The codon AUG serves a dual function; it codes for the amino acid methionine and also acts as the initiation or start signal for translation. It does not code for phenylalanine. On the other hand, the codons AAA and AAG are both redundant signals that specifically code for the amino acid lysine.

55. (1) siRNA
Protein synthesis, or translation, requires several types of RNA molecules to function together. Messenger RNA carries the genetic code, transfer RNA brings the correct amino acids, and ribosomal RNA forms the structural and catalytic core of the ribosome. While other RNAs like small interfering RNAs play roles in gene regulation and silencing, they are not directly required for the translation process itself.

56. (3) repetitive DNA
DNA fingerprinting is a powerful tool for individual identification that focuses on specific regions of the genome. While most DNA is identical between humans, certain areas consist of repetitive DNA sequences where a short sequence is repeated many times. These repetitive regions show high levels of variation among individuals and are used to create a unique genetic profile for forensic or diagnostic purposes.

57. (1) Adenine pairs with thymine through two H-bonds.
The double-helical structure of DNA is stabilized by specific hydrogen bonding between nitrogenous bases on opposite strands. According to the base-pairing rules established by Watson and Crick, the purine adenine always pairs with

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components ensure the efficient use of lactose as an alternative energy source.

39. (2) chromosome 1
The Human Genome Project was a massive international effort to sequence all the base pairs in the human genome. While most of the sequencing was completed by two thousand three, the final phase involved the completion of chromosome one. Due to its large size and complexity, chromosome one was the last of the twenty-four human chromosomes to be fully sequenced in May two thousand six.

40. (3) all genes that are expressed as RNA
In the field of genomics, researchers use various strategies to identify and study genes. Expressed Sequence Tags, or ESTs, specifically refer to a method where only the parts of the genome that are expressed as RNA are sequenced. This approach focuses on identifying functional genes that are actively being transcribed into messenger RNA, providing insights into the protein-coding potential of the organism.

41. (2) (A), (C), (D) only
Chromatin organization involves different levels of DNA packaging. Euchromatin is a loosely packed form of chromatin that is transcriptionally active. In a nucleosome, the negatively charged DNA wraps around a positively charged histone octamer. Histones are particularly rich in the basic amino acids lysine and arginine. These features are essential for the efficient compaction of genetic material within the eukaryotic cell nucleus.

42. (1) 3.3×10^9 bp
To determine the number of base pairs in a DNA molecule of a specific length, one must divide the total length by the distance between consecutive base pairs. Given a length of one point one one meters and a distance of zero point three four nanometers per base pair, the calculation yields approximately three point three times ten to the power of nine.

43. (3) 60 cells
DNA replication is semi-conservative, meaning each new double helix contains one original and one new strand. Starting with ten cells having heavy nitrogen DNA, after twenty minutes, all twenty cells have hybrid DNA. After forty minutes, twenty cells have hybrid DNA and twenty have light DNA. After sixty minutes, twenty cells remain hybrid while sixty cells contain only light nitrogen DNA.

44. (1) the small subunit of ribosome encounter mRNA
Translation is the process of synthesizing proteins from an mRNA template. This process is initiated when the small subunit of a ribosome binds to the messenger RNA molecule. The small subunit scans the RNA until it finds the start codon. Once this initial interaction occurs, the larger ribosomal subunit joins the complex, and the assembly of the polypeptide chain can formally begin.

45. (3) z, y, a genes will not be translated
In this specific mutation, the repressor protein produced by the i-gene is unable to bind the inducer molecule, lactose. Consequently, the repressor remains permanently bound to the operator region, even when lactose is present. This constant blockage prevents RNA polymerase from transcribing the structural genes. As a result, the z, y, and a genes will not be expressed or translated.

46. (1) Sequence annotation
Genome sequencing methodologies can vary in their approach. One strategy involves sequencing the entire genome without prior knowledge of specific gene locations. After obtaining the sequence, researchers use computational tools to identify different segments and assign biological functions to them. This systematic approach of identifying and describing all functional elements within a genomic sequence is formally known as sequence annotation in bioinformatics.

47. (3) both genetic mapping and DNA fingerprinting
DNA polymorphism refers to variations in the DNA sequence among individuals that occur at a frequency greater than one percent in the population. These variations are highly heritable and serve as essential markers in genetic research. Specifically, DNA polymorphism provides the fundamental basis for both genetic mapping of chromosomes and DNA fingerprinting, which is used for individual identification and determining biological relationships.

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Tags, or ESTs, are a specific approach used to identify functional parts of the genome. This method focuses on sequencing short fragments of DNA that are derived from complementary DNA libraries. Since these sequences represent parts of genes that are actively being expressed as RNA, they help researchers identify protein-coding regions.

68. (2) bacterium
The semi-conservative nature of DNA replication was first experimentally demonstrated by Matthew Meselson and Franklin Stahl in nineteen fifty-eight. They used the bacterium Escherichia coli as their experimental model. By growing the bacteria in media containing different isotopes of nitrogen, they were able to track the density of the DNA over successive generations, confirming that each new molecule contains one parental strand.

69. (1) Ribozyme - Nucleic acid
Biological molecules and genetic concepts are defined by their specific structures and functions. A ribozyme is a unique type of RNA molecule that possesses catalytic activity, making it a nucleic acid with enzymatic properties. In contrast, a dihybrid cross involves studying two traits, while transduction and transformation are methods of genetic transfer in bacteria discovered by other scientists through different experimental protocols.

70. (2) Punnett square was developed by a British scientist.
Scientific history includes several key milestones in the development of genetics. The Punnett square, a widely used tool for predicting the outcomes of genetic crosses, was developed by the British scientist Reginald Punnett. Other significant events include the discovery of linkage by Thomas Hunt Morgan and the realization that spliceosomes are involved in RNA processing rather than the direct process of translation.

71. (1) AGGUAUCGCAU
Transcription produces an RNA molecule that is complementary to the DNA template strand and identical to the DNA coding strand. The only major difference is that RNA contains uracil instead of thymine. Therefore, if the coding strand sequence is provided, the messenger RNA sequence will be exactly the same, but every occurrence of thymine will be replaced by a uracil base.

72. (1) polysome
In many biological systems, multiple ribosomes can be found attached to a single messenger RNA molecule at the same time. This arrangement resembles beads on a string when viewed under an electron microscope. This complex, known as a polysome or polyribosome, allows for the simultaneous synthesis of several copies of the same protein, thereby maximizing the speed and efficiency of the translation process.

73. (4) Francois Jacob and Jacques Monod - Lac operon
Scientific history is marked by famous pairings of researchers and their discoveries. Francois Jacob and Jacques Monod are renowned for their work on the lac operon, which elucidated how genes are regulated in bacteria. Other important contributions include Griffith's work on transformation, Hershey and Chase's proof of DNA as genetic material, and Meselson and Stahl's demonstration of semi-conservative replication in bacterial cells.

74. (3) an enhancer
An operon is a functional unit of genomic DNA found in prokaryotes that contains a cluster of genes under the control of a single promoter. The key components typically include the structural genes that code for proteins, a promoter where RNA polymerase binds, and an operator that interacts with a repressor. Enhancers are regulatory elements more commonly associated with eukaryotic gene expression control.

75. (2) the DNA is condensed into a chromatin fibre
In eukaryotic cells, DNA is highly organized into chromatin. The basic unit of this organization is the nucleosome, where DNA is wrapped around a core of histone proteins. The binding of the H1 histone protein to the exterior of the nucleosome core helps to stabilize the structure and facilitate the further condensation of nucleosomes into a more compact thirty-nanometer chromatin fibre.

76. (1) Hershey and Chase
Although early experiments suggested that DNA might be the carrier of genetic information, the final and most widely accepted proof came from Alfred Hershey and Martha Chase. In nineteen fifty-two, they used radioactive isotopes

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Frederick Griffith observed that non-pathogenic bacteria could be transformed into pathogenic ones when mixed with heat-killed virulent bacteria. This demonstrated that some substance, which he called the transforming principle, was transferred between the bacteria, later identified as the genetic material.

96. (1) 5' - 3' ; 3' - 5'
The synthesis of RNA by RNA polymerase always occurs in a specific direction. The enzyme adds new nucleotides to the three-prime end of the growing RNA strand, meaning synthesis proceeds from five-prime to three-prime. To do this, the enzyme must read the DNA template strand in the opposite direction, which is three-prime to five-prime, ensuring correct complementary base pairing throughout the process.

97. (1) Transcription - Writing information from DNA to tRNA.
In molecular biology, various terms describe the flow of genetic information. Transcription is the process where genetic information from a DNA template is copied into a messenger RNA molecule. Describing it as writing information from DNA to transfer RNA is incorrect. Translation involves using the code in messenger RNA to build proteins, while operons and repressor proteins are key elements of gene regulation.

98. (1) A - Transcription, B - Translation, C - Francis Crick
The central dogma describes the fundamental flow of genetic information. DNA serves as the template for transcription to produce messenger RNA. This RNA is then translated into a specific protein sequence. This critical concept, which explains how genetic instructions lead to biological traits, was first proposed by Francis Crick. It provides the framework for understanding how information is managed in all living cells.

99. (4) A-Francis Crick, B-Translation, C-Transcription
Francis Crick proposed the central dogma to explain how genetic information is utilized in organisms. The process begins with transcription, where DNA is used to synthesize messenger RNA. This is followed by translation, where the RNA sequence is used to assemble a specific protein. This directional flow of information from nucleic acids to proteins is a cornerstone of modern molecular biology and genetics.

100. (2) Ambiguous
The genetic code has several distinctive properties that ensure accurate protein synthesis. It is non-overlapping, meaning each base is part of only one codon. It is degenerate, as multiple codons can specify the same amino acid. It is also nearly universal across all life forms. Crucially, the code is unambiguous, meaning that each specific codon always codes for only one particular amino acid.

101. (3) β-galactosidase
A nonsense mutation creates a premature stop codon in a gene sequence. In the lac operon, the genes are transcribed as a single unit. If a nonsense mutation occurs in the lac y-gene, which is located after the lac z-gene, the transcription of lac z will still occur, producing functional beta-galactosidase. However, the translation will stop prematurely, preventing the production of permease and transacetylase.

102. (1) usually not expressed unless a signal turns them "on".
Inducible operons are a type of genetic regulatory system found in bacteria. In these systems, the structural genes are usually not expressed under normal conditions. They remain in an "off" state because a repressor protein is bound to the operator. The operon is only turned "on" or induced when a specific signal molecule, such as an inducer, is present in the environment.

103. (1) VNTR
DNA fingerprinting utilizes the variation found in repetitive DNA sequences between individuals. One of the most common techniques involves analyzing Variable Number Tandem Repeats, or VNTRs. These are sequences where a short DNA motif is repeated many times, and the number of repeats varies significantly from person to person. Comparing these patterns allows for the precise identification of individuals or biological relatives.

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104. (4) splicing.
Primary RNA transcripts in eukaryotes contain both coding and non-coding regions. Splicing is the essential post-transcriptional process where the non-coding introns are removed from the transcript. The remaining coding regions, known as exons, are then joined together in a specific,

86. (3) AUG
The translation of messenger RNA into a protein sequence always begins at a specific site called the start or starter codon. In almost all organisms, this codon is AUG. In addition to signaling the commencement of protein synthesis, AUG also codes for the amino acid methionine. Other codons like UAA, UAG, and UGA serve as stop signals to terminate translation.

87. (3) polysome
In many cells, multiple ribosomes can be found attached to a single messenger RNA molecule at the same time. This arrangement resembles beads on a string when viewed under an electron microscope. This complex, known as a polysome or polyribosome, allows for the simultaneous synthesis of several copies of the same protein, thereby maximizing the speed and efficiency of the translation process.

88. (1) Lactose
The lac operon is a regulated system where genes are expressed only when needed. For the operon to be turned on, an inducer molecule must be present to inactivate the repressor protein. In the case of this specific operon in Escherichia coli, lactose serves as the primary inducer. When lactose is available, it allows for the transcription of genes required for its metabolism.

89. (4) Zinc finger analysis
DNA fingerprinting relies on various molecular biology techniques to identify unique genetic patterns. Common methods involve using restriction enzymes to cut DNA, polymerase chain reaction to amplify samples, and DNA-DNA hybridization with specific probes. Zinc finger analysis is a technique used for studying protein-DNA interactions and gene editing but is not a standard component of the typical DNA fingerprinting protocols used today.

90. (1) G 17%, A 33%, T 33%
Based on Chargaff's rules, in double-stranded DNA, the percentage of cytosine is equal to guanine, and adenine is equal to thymine. If cytosine is seventeen percent, guanine must also be seventeen percent. Together, they make up thirty-four percent. The remaining sixty-six percent is divided equally between adenine and thymine. Therefore, both adenine and thymine will each account for thirty-three percent.

91. (2) Chargaff's rule
RNA is a single-stranded nucleic acid that contains heterocyclic nitrogenous bases and five-prime and three-prime ends. While some RNA molecules can show local complementary base pairing, they generally do not follow Chargaff's rule. This rule states that the amount of adenine equals thymine and guanine equals cytosine, which is a characteristic specifically observed in the base composition of double-stranded DNA molecules.

92. (4) negative and inducible because repressor protein prevents transcription.
The lac operon is regulated by a negative inducible mechanism. It is negative because the product of the lac i-gene is a repressor protein that normally binds to the operator and prevents transcription. It is inducible because the presence of lactose, the inducer, can remove this inhibition. This allows the cell to respond to environmental changes and only produce enzymes when lactose is available.

93. (1) Genome, chromosome, gene, nucleotide
Genetic material is organized into a hierarchical structure within living organisms. The largest unit is the genome, which encompasses the entire set of genetic information. The genome is divided into several chromosomes, which are long DNA molecules. Each chromosome contains many individual genes, which are the functional units of heredity. Finally, genes are made up of basic building blocks called nucleotides.

94. (4) shows high degree of polymorphism in population and also the same degree of polymorphism in an individual, which is heritable from parents to children.
Satellite DNA consists of highly repetitive sequences that do not typically code for proteins. It is important in genetics because it exhibits a high degree of polymorphism among individuals in a population. This variation is consistent within an individual and is inherited from parents to offspring. These unique patterns form the basis for DNA fingerprinting, a technique used for individual identification and paternity testing.

95. (3) Griffith
The discovery of transformation was a landmark event in biology that provided early evidence for the role of DNA. In nineteen twenty-eight,

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the pyrimidine thymine. This specific interaction is held together by the formation of two hydrogen bonds. In contrast, guanine and cytosine pairs are joined by three hydrogen bonds.

58. (3) 2.2 meters
To calculate the length of DNA in a mammalian cell, the total number of base pairs is multiplied by the distance between each pair. With six point six times ten to the power of nine base pairs and a distance of zero point three four nanometers, the result is approximately two point two meters. This immense length is compactly packaged within the nucleus.

59. (4) RNA polymerase
During the process of transcription, the DNA double helix must be locally unwound to allow the enzyme to access the template strand. This opening of the DNA helix is facilitated by RNA polymerase itself. As the enzyme moves along the DNA, it breaks the hydrogen bonds between the base pairs, creating a transcription bubble where the synthesis of the RNA strand occurs.

60. (3) aminoacylation of tRNA
Translation is the complex biological process of building proteins from an RNA template. Before the actual assembly of amino acids can occur, each amino acid must be linked to its specific transfer RNA molecule. This initial activation step is known as the aminoacylation of transfer RNA. It ensures that the correct amino acid is available to be incorporated into the growing polypeptide chain.

61. (3) adenine and guanine
Nucleic acids, DNA and RNA, are composed of nucleotides containing nitrogenous bases. These bases are classified into two groups: purines and pyrimidines. Purines consist of a double-ring structure and include adenine and guanine. Both of these purines are fundamental components of both DNA and RNA molecules. Pyrimidines differ between the two, with thymine found in DNA and uracil found primarily in RNA.

62. (2) 5'UACGUACGUACGUAC 3'
The synthesis of messenger RNA follows the sequence of the DNA coding strand, with the critical exception that uracil is substituted for thymine. Both the coding strand and the resulting mRNA share the same five-prime to three-prime polarity. Therefore, an mRNA produced from the given DNA will have a sequence identical to the coding strand, but with uracil replacing every thymine base.

63. (3) 1-ii, 2-iii, 3-i
In eukaryotic transcription, three different RNA polymerases produce specific types of RNA. RNA polymerase one is responsible for transcribing most ribosomal RNAs. RNA polymerase two synthesizes the precursors of messenger RNA, known as heterogeneous nuclear RNA. RNA polymerase three handles the transcription of transfer RNAs and other small RNA molecules. This division of labor ensures that all necessary RNA components are correctly synthesized.

64. (1) Deletion of GGU from 7th, 8th and 9th positions
A reading frame is established by the triplet nature of the genetic code. If nucleotides are inserted or deleted in multiples of three, the reading frame for the rest of the sequence remains unchanged, although specific amino acids may be added or removed. Deleting three consecutive nucleotides, such as GGU from the specified positions, removes exactly one codon without shifting the subsequent sequence.

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65. (4) Genetic code is nearly universal.
The ability to produce human insulin within bacterial cells using recombinant DNA technology relies on a fundamental property of the genetic code. Because the genetic code is nearly universal, the same triplets of nucleotides specify the same amino acids in both humans and bacteria. This allows the bacterial translation machinery to accurately interpret the human gene and synthesize the functional human insulin protein.

66. (4) (iii) (i) (iv) (ii)
The lac operon includes several genes that produce specific proteins for lactose utilization. The i-gene acts as a regulatory gene, producing the repressor protein. The structural z-gene encodes the enzyme beta-galactosidase. The y-gene is responsible for producing permease, which aids in lactose transport. Finally, the a-gene codes for transacetylase. These components work together to regulate the metabolism of lactose in the cell.

67. (2) genes expressed as RNA
Genomics involves various techniques to map and sequence organisms. Expressed Sequence

defined order. This results in a continuous, functional messenger RNA molecule that can be accurately translated into a protein by the cell.

105. (2) UAGAC
To find the complementary RNA sequence for a given DNA strand, one must follow the base-pairing rules while considering the differences between DNA and RNA. Adenine in DNA pairs with uracil in RNA, thymine with adenine, cytosine with guanine, and guanine with cytosine. Therefore, a DNA sequence of ATCTG will yield an RNA sequence of UAGAC, maintaining the correct complementary relationship.

106. (2) nucleolus
The nucleolus is a dense, prominent structure located within the nucleus of eukaryotic cells. It serves as the primary site for the active synthesis of ribosomal RNA and the assembly of ribosomal subunits. Large amounts of ribosomal RNA are produced here by RNA polymerase one to meet the cell's ongoing need for ribosomes, which are essential for carrying out protein synthesis.

107. (1) The inducer
A transcription unit in DNA is defined by specific regions that are required for the synthesis of an RNA molecule. These include a promoter, which initiates transcription; structural genes, which contain the coding information; and a terminator, which signals the end of the process. An inducer is a molecule involved in the regulation of an operon, rather than a physical part of the unit.

108. (1) tRNA
Eukaryotic cells rely on multiple RNA polymerase enzymes for specialized tasks. RNA polymerase three is located in the nucleoplasm and is specifically responsible for transcribing several types of small RNA molecules. Its primary targets include all transfer RNAs and the five-S fraction of ribosomal RNA. Therefore, the removal or inhibition of this enzyme would directly prevent the synthesis of functional transfer RNA molecules.

109. (1) molecular analysis of profiles of DNA samples
DNA fingerprinting is a sophisticated laboratory technique used to identify individuals based on their unique genetic makeup. It involves the molecular analysis of profiles derived from specific regions of DNA samples. By examining the patterns of variation, such as repetitive sequences, researchers can create a genetic profile that is unique to an individual, similar to how physical fingerprints are used for identification purposes.

110. (3) Nucleosomes
In eukaryotic chromosomes, DNA is packaged into a highly organized structure called chromatin. When viewed under an electron microscope, chromatin often appears as "beads-on-a-string." These "beads" are individual nucleosomes, which consist of a segment of DNA wrapped around a core of histone proteins. This fundamental level of organization is essential for compacting the vast amount of genetic material within the small nucleus.

111. (4) bacterial virus.
The definitive proof that DNA is the genetic material resulted from experiments conducted on bacterial viruses, also known as bacteriophages. Alfred Hershey and Martha Chase used radioactive isotopes to track the components of these viruses during infection. They demonstrated that only the viral DNA, and not the protein coat, enters the bacterial host to direct the production of new viruses, confirming DNA's genetic role.

112. (4) 23S rRNA
While most biological catalysts are proteins called enzymes, certain RNA molecules also possess catalytic properties. In bacterial cells, the twenty-three S ribosomal RNA is a primary example of such a ribozyme. It is a critical component of the large ribosomal subunit and plays a vital role in protein synthesis by catalyzing the formation of peptide bonds between amino acids in the growing polypeptide.

113. (4) HIV
The central dogma of molecular biology typically describes the flow of information from DNA to RNA to protein. However, some viruses, such as the Human Immunodeficiency Virus, do not strictly follow this path. As a retrovirus, HIV contains an RNA genome and uses the enzyme reverse transcriptase to synthesize DNA from its RNA template. This reverse flow of genetic information is an exception.

114. (3) one nucleotide with another nucleotide
Polynucleotide chains, such as DNA and RNA, are formed by linking individual nucleotides together. These links are created through

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three-prime to five-prime phosphodiester bonds. Specifically, the phosphate group of one nucleotide reacts with the hydroxyl group on the three-prime carbon of the sugar in another nucleotide. This repeated process builds the sugar-phosphate backbone, serving to join one nucleotide to the next in the chain.

115. (2) The gene for producing insulin is present in every body cell.
In multicellular organisms, every somatic cell contains the complete genome of the individual. This means that even though specific genes are only active in certain tissues, the gene for producing insulin is present in the DNA of every body cell, whether it is a muscle cell, a skin cell, or a pancreatic cell. Gene regulation ensures that insulin is only produced where needed.

116. (2) nucleus
Eukaryotic cells exhibit a high degree of compartmentalization. The processes of transcription, where DNA is copied into RNA, and subsequent RNA processing steps like splicing and capping, all take place within the nucleus. These modifications are essential for producing a mature, functional messenger RNA. Once fully processed, the mRNA is then exported through nuclear pores into the cytoplasm, where translation into protein occurs.

117. (2) ambiguous
The genetic code has several key features that ensure its reliability. It is degenerate, meaning multiple codons can code for the same amino acid. It is nearly universal across all organisms and is highly specific. A critical feature of the genetic code is that it is unambiguous, meaning that any given codon always specifies exactly one amino acid. Therefore, being ambiguous is not a feature.

118. (3) (ii) and (iv)
The lac operon was famously elucidated by Francois Jacob and Jacques Monod. It represents a system for regulating gene expression in response to environmental conditions. In the absence of lactose, the repressor protein binds to the operator region, physically blocking transcription. When lactose is present, it acts as an inducer by binding to the repressor, allowing the structural genes to be transcribed for metabolism.

119. (2) one regulatory gene and three structural genes
The lac operon is a coordinated system of genes used by bacteria for lactose metabolism. It typically consists of one regulatory gene and three structural genes. The regulatory i-gene produces a repressor protein that controls the operon's activity. The three structural genes, known as z, y, and a, encode the enzymes beta-galactosidase, permease, and transacetylase, respectively, which are all needed for utilizing lactose.

120. (1) Escherichia coli
Matthew Meselson and Franklin Stahl provided the first experimental evidence for the semi-conservative mode of DNA replication. In nineteen fifty-eight, they used the bacterium Escherichia coli and isotopes of nitrogen to track DNA density over several generations. Their results showed that each new DNA molecule consists of one original parental strand and one newly synthesized strand, confirming the semi-conservative model of replication.

121. (4) Nirenberg and Mathaei
The nature of the genetic code was determined through a series of ingenious biochemical experiments. Marshall Nirenberg and Heinrich Mathaei played a crucial role by using synthetic RNA templates in cell-free systems. Their work demonstrated that a sequence of three nucleotides, or a triplet, specifically codes for a particular amino acid. This discovery cracked the code and established the triplet nature of the genetic language.

122. (4) A codon in mRNA is read in a non-contiguous fashion.
The genetic code is characterized by several fundamental properties. It is nearly universal, degenerate, and unambiguous. One essential feature is that the code is read in a contiguous fashion, meaning that codons in messenger RNA are read one after another without any overlapping or skipping of bases. Therefore, the idea that the code is read in a non-contiguous fashion is incorrect.

123. (2) there are two strands which run anti-parallel- one in 5' → 3' direction and other in 3' → 5'
A DNA molecule consists of two polynucleotide strands that form a double helix. These strands are oriented in an anti-parallel fashion, meaning

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they run in opposite directions. One strand is oriented in the five-prime to three-prime direction, while the other runs in the three-prime to five-prime direction. This arrangement is crucial for the specific base-pairing and hydrogen bonding that stabilize the DNA structure.

124. (2) Adenine, Thymine - Purines
Nitrogenous bases in nucleic acids are classified as either purines or pyrimidines. Purines include adenine and guanine, while pyrimidines include cytosine, thymine, and uracil. Pairing adenine with thymine and calling them both purines is incorrect because adenine is a purine and thymine is a pyrimidine. Correct classification is essential for understanding the structure and base-pairing rules of DNA and RNA molecules.

125. (4) UAG, UGA - Stop
The genetic code uses specific codons to signal the beginning and end of protein synthesis. AUG is the most common start codon and also codes for methionine. Several stop codons, including UAG, UGA, and UAA, do not code for any amino acids. Instead, they signal the translation machinery to terminate the assembly of the polypeptide chain and release the finished protein molecule.

126. (3) several ribosomes attached to a single mRNA
Protein synthesis efficiency is often increased by the formation of polysomes. A polysome, or polyribosome, consists of several ribosomes that are simultaneously attached to and translating a single messenger RNA molecule. This allows the cell to produce multiple copies of the same polypeptide from one mRNA template at the same time, which is particularly useful when high levels of a specific protein are needed.

127. (1) magnesium
Ribosomes are composed of two subunits, a small one and a large one, which must come together to perform translation. The association and stability of these two subunits are highly dependent on the concentration of specific ions in the surrounding environment. In particular, a critical level of magnesium ions is required to keep the ribosomal subunits united during the process of protein synthesis.

128. (4) 3.4 nm.
B-form DNA is the most common structural configuration of the DNA double helix under physiological conditions. In this form, the helix makes one complete turn approximately every ten base pairs. Since the distance between consecutive base pairs is about zero point three four nanometers, the total length of one full turn of the B-DNA helix is approximately three point four nanometers.

129. (4) the phosphate groups at the start of two DNA strands are in opposite position (pole).
The term anti-parallel describes the orientation of the two strands in a DNA double helix. It means that the two sugar-phosphate backbones run in opposite directions. Specifically, the five-prime end of one strand, characterized by a phosphate group, is aligned with the three-prime end of the other strand. This arrangement ensures that the nitrogenous bases can properly align for hydrogen bonding between the strands.

130. (1) Beadle and Tatum
The connection between genes and metabolic processes was first clearly articulated by George Beadle and Edward Tatum. Through their research on the mold Neurospora crassa, they demonstrated that mutations in specific genes led to deficiencies in particular enzymes. This led them to propose the “one gene-one enzyme” hypothesis, which states that each gene is responsible for the production of a specific enzyme in a cell.

131. (3) Neomycin
Different antibiotics work by interfering with specific stages of bacterial protein synthesis. Neomycin is an aminoglycoside antibiotic that disrupts the translation process. Specifically, it inhibits the proper interaction between the transfer RNA and the messenger RNA within the ribosome. This leads to the misreading of the genetic code and prevents the accurate assembly of polypeptide chains, ultimately inhibiting bacterial growth and survival.

132. (3) mRNA
During the process of translation, the specific sequence of amino acids in a growing protein is determined by the sequence of nucleotides in messenger RNA. The messenger RNA carries the genetic instructions from the DNA in the nucleus to the ribosomes in the cytoplasm. Each triplet of bases, or codon, in the mRNA specifies a particular amino acid, ensuring the correct protein is built.

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189. (2) nucleoplasm
Messenger RNA is the molecule that carries genetic information from the DNA to the protein-making machinery. In eukaryotic cells, the transcription process, where DNA is used as a template to synthesize RNA, occurs primarily within the nucleus. Therefore, the maximum formation of messenger RNA takes place in the nucleoplasm. Once the RNA is synthesized and processed, it is then transported out of the nucleus into the cytoplasm for translation.

190. (1) UAG
Terminal codons, also known as stop or nonsense codons, are essential for concluding the process of translation. There are three specific codons that serve this purpose: UAG, UAA, and UGA. These triplets do not specify any amino acid. Instead, when a ribosome reaches a terminal codon on the messenger RNA, it signals the release of the newly synthesized polypeptide chain and the dissociation of the ribosomal subunits.

191. (4) UAAGCUAC.
Transcription involves creating an RNA transcript from a DNA template following specific base-pairing rules. Adenine in DNA is transcribed into uracil in RNA, thymine into adenine, cytosine into guanine, and guanine into cytosine. For a DNA sequence of ATTCGATG, the complementary RNA transcript would have the sequence UAAGCUAC. This ensures that the genetic information is accurately transferred from the DNA to the RNA molecule for protein synthesis.

192. (1) exons
Many eukaryotic genes have a "split" organization, meaning they contain alternating coding and non-coding regions. The sequences that contain the actual genetic information for building a protein are called exons. During the maturation of the primary RNA transcript, the non-coding regions, known as introns, are removed, and the exons are joined together. This results in a continuous messenger RNA that is ready for translation by the cell's ribosomes.

193. (1) CAT GAT GAT G
A frame shift mutation occurs when a nucleotide is inserted or deleted in a DNA sequence, changing the reading frame of all subsequent codons. If a cytosine base is inserted at the very beginning of the sequence ATG ATG ATG, the triplets will be shifted. The first codon will become CAT, followed by GAT, GAT, and a remaining G. This dramatically alters the amino acid sequence of the resulting protein.

194. (1) tRNA
Transfer RNA molecules function as adapters that link specific codons to their corresponding amino acids. A critical feature of each tRNA is the anticodon, which is an unpaired triplet of bases in an exposed position on one of its loops. This anticodon is complementary to a specific codon on the messenger RNA. Through base-pairing, the anticodon ensures that the correct amino acid is incorporated into the growing polypeptide chain.

195. (1) The lac operon is induced.
Escherichia coli cells exhibit sophisticated regulation of gene expression to adapt to their environment. When glucose, their preferred energy source, is depleted and lactose is provided, the bacteria must produce enzymes to metabolize the sugar. In this situation, the lac operon is induced. Lactose acts as an inducer that binds to the repressor protein, allowing the structural genes to be transcribed so the cell can utilize lactose for energy.

196. (4) inducible operon.
Operons are units of genetic regulation that allow for the coordinated control of related genes. The lac operon is the classic example of an inducible operon. This means that the genes are normally not expressed, but their transcription can be turned on, or induced, in the presence of a specific molecule, such as lactose. This allows the organism to conserve energy by only producing enzymes when they are actually needed.

197. (4) inducer.
In gene regulation, an environmental agent that can trigger the transcription of an operon is known as an inducer. These molecules work by interacting with a regulatory protein, typically a repressor. By binding to the repressor, the inducer prevents it from attaching to the operator DNA. This clears the way for RNA polymerase to begin the transcription of structural genes, allowing the cell to produce specific proteins as needed.

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pairing rules, adenine in DNA pairs with uracil in RNA, and thymine in DNA pairs with adenine in RNA. Therefore, if the DNA sequence being transcribed is ATACG, the resulting messenger RNA sequence will be UAUGC, maintaining the correct complementary and anti-parallel orientation.

143. (1) protein structure
A mutation at a genetic locus involves a change in the DNA sequence. This alteration can lead to the production of a messenger RNA with a different set of codons. During translation, these new codons may specify different amino acids, resulting in a protein with an altered primary structure. Since protein structure determines function, this change can significantly affect the physical characters of the organism.

144. (3) transition
Mutations in DNA can be categorized based on the type of base substitution that occurs. A transition mutation happens when one purine is replaced by another purine, such as adenine being replaced by guanine, or one pyrimidine is replaced by another pyrimidine. Transversion, on the other hand, involves the replacement of a purine by a pyrimidine or vice versa. Transitions are generally more common than transversions.

145. (4) Satellite DNA occurring as highly repeated short DNA segments.
DNA fingerprinting relies on the fact that while most of the human genome is identical, certain regions are highly variable between individuals. Satellite DNA, which consists of short DNA segments that are repeated many times, exhibits a high level of polymorphism. The unique number and pattern of these repeats in an individual's genome provide a distinctive genetic profile that can be used for identification.

146. (1) promoter
The process of transcription is carefully regulated to ensure that genes are expressed at the right time and in the correct amounts. For transcription to begin, the enzyme RNA polymerase must first identify and bind to a specific DNA sequence located upstream of the structural gene. This recognition site is known as the promoter, and it serves as the essential starting signal for RNA synthesis.

147. (1) A polypeptide of 24 amino acids will be formed.
In the genetic code, certain codons signal the termination of protein synthesis. If a codon that normally codes for an amino acid, such as UAU for tyrosine, is mutated into a stop codon like UAA, translation will end prematurely at that point. In a gene for a fifty amino acid protein, a stop codon at the twenty-fifth position will result in a twenty-four amino acid polypeptide.

148. (4) UAC - Tyrosine
The genetic code is highly specific, with each codon corresponding to a particular amino acid or signaling a stop in translation. For example, the codon UAC specifically codes for the amino acid tyrosine. Other codons have different roles, such as UAA, UAG, and UGA, which act as stop signals. AUG is uniquely used as the start codon and also codes for the amino acid methionine.

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149. (4) third member of a codon.
The degeneracy of the genetic code means that multiple codons can specify the same amino acid. This phenomenon is often attributed to the flexibility of the third base in a codon, a concept known as the wobble hypothesis. In many cases, changing the third nucleotide of a codon does not change the amino acid it encodes, providing a level of protection against certain mutations.

150. (3) 61
The genetic code consists of sixty-four possible triplet codons derived from the four nitrogenous bases. Out of these, sixty-one codons are sense codons that specify the twenty essential amino acids used in protein synthesis. The remaining three codons, UAA, UAG, and UGA, are nonsense or stop codons that do not code for any amino acid but instead signal the termination of the translation process.

151. (4) association of 50S subunit of ribosome with initiation complex.
The initiation of translation in prokaryotes is a complex process requiring several initiation factors and energy. One critical step involves the assembly of the complete ribosome on the messenger RNA. Specifically, the binding of the large fifty-S ribosomal subunit to the initiation complex, which already includes the thirty-S subunit and the initiator tRNA, requires the hydrolysis of a GTP molecule to provide the necessary energy.

specific orientation is crucial for its proper fit within the ribosomal sites during the process of translation.

171. (3) AUG
The initiation of protein synthesis is a precise process that begins at a specific site on the messenger RNA. This site is marked by the initiation, or start, codon. In nearly all living organisms and cell types, the codon AUG serves as this essential signal. In addition to starting translation, AUG also specifies the incorporation of the amino acid methionine into the beginning of the polypeptide.

172. (2) nucleus only
In eukaryotic cells, the majority of the genetic information is stored in the form of DNA within the nucleus. The DNA is organized into chromosomes and is responsible for directing all cellular activities and heredity. While small amounts of DNA can also be found in semi-autonomous organelles like mitochondria and chloroplasts, the nucleus remains the primary location for genomic DNA in the cell.

173. (2) circular DNA without histones
Prokaryotic organisms, such as bacteria, have a simpler genetic organization compared to eukaryotes. Their genetic material typically consists of a single, large, circular DNA molecule. Unlike the DNA in eukaryotic chromosomes, prokaryotic DNA is not associated with histone proteins. Instead, it is organized in a region called the nucleoid with the help of other basic proteins and RNA molecules to maintain its compact structure.

174. (1) AT-GC
The structure of the DNA double helix is maintained by specific base-pairing rules between the nitrogenous bases of the two strands. Adenine always forms hydrogen bonds with thymine, and guanine always pairs with cytosine. This consistent AT-GC association ensures that the two strands are complementary to each other. These rules are fundamental to the accurate replication and transcription of genetic information in all organisms.

175. (3) repetitive sequences are present in eukaryotes
Eukaryotic and prokaryotic genomes have several significant differences in their organization and complexity. One major distinction is that eukaryotic genomes contain many repetitive DNA sequences, which are sequences that occur in multiple copies throughout the genome. In contrast, prokaryotic genomes are generally more streamlined and consist mostly of unique coding sequences. Additionally, eukaryotic DNA is associated with histones and lacks the operon-based organization common in bacteria.

176. (3) DNA is the genetic material
The experiments conducted by Frederick Griffith using Streptococcus pneumoniae, also known as Pneumococcus, were foundational in genetics. He demonstrated that a "transforming principle" could be transferred from heat-killed virulent bacteria to live non-virulent bacteria, giving them pathogenic properties. Later research identified this principle as DNA, thereby proving that DNA is the actual genetic material responsible for carrying and transferring biological information between organisms.

177. (3) AUG
In all eukaryotic organisms, the process of translation begins at a specific start signal on the messenger RNA. This signal is provided by the initiation codon, which is universally AUG. This codon not only marks the starting point for the assembly of the polypeptide chain by the ribosome but also codes for the amino acid methionine, which is usually the first amino acid incorporated.

178. (2) repressor
The regulation of an operon involves several key components that work together to control gene expression. In this system, the regulator gene plays a crucial role by producing a specific protein. This protein acts as a repressor, which can bind to the operator region of the operon. By binding to the operator, the repressor physically prevents RNA polymerase from transcribing the structural genes when they are not needed.

179. (2) regulatory genes
Gene expression is a highly controlled process that allows cells to respond to internal and external signals. Specific genes are responsible for regulating the activity of other genes by turning their transcription on or off. These are known as regulatory genes. They produce proteins, such as activators or repressors, that interact with DNA sequences to either facilitate or block the binding of RNA polymerase to the structural genes.

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"off" switch. In the absence of an inducer like lactose, the repressor protein has a high affinity for a specific DNA sequence called the operator gene. When the repressor binds to the operator, it prevents RNA polymerase from transcribing the structural genes, thus stopping the production of enzymes.

162. (1) 5' → 3'
The synthesis of a messenger RNA molecule by the enzyme RNA polymerase always proceeds in a single, specific direction. The enzyme adds new ribonucleotides to the three-prime hydroxyl end of the growing RNA strand. Consequently, the newly formed messenger RNA is always synthesized in the five-prime to three-prime direction. This polarity is a fundamental characteristic of all nucleic acid synthesis processes in living cells.

163. (3) one gene contains one cistron
In modern molecular genetics, the term cistron is often used synonymously with the term gene. Specifically, a cistron is defined as a segment of DNA that encodes a single functional polypeptide chain. Therefore, when a gene is described as a functional unit that produces one specific protein, it is essentially equivalent to one cistron. This relationship forms the basis of the "one gene-one polypeptide" concept.

164. (3) 3
The nucleus of eukaryotic cells contains a more complex transcriptional system than that found in prokaryotes. There are three distinct types of RNA polymerase enzymes, each specialized for transcribing different classes of genes. RNA polymerase one produces ribosomal RNA, RNA polymerase two synthesizes messenger RNA precursors, and RNA polymerase three is responsible for transfer RNA and other small RNAs. This specialization allows for precise control.

165. (1) co-repressor binds with repressor
In a negative operon system, the regulation is mediated by a repressor protein that inhibits transcription. In some cases, the repressor is produced in an inactive form and requires the binding of a small molecule, known as a co-repressor, to become functional. Once the co-repressor binds with the repressor, the complex can then attach to the operator region, thereby blocking the synthesis of the structural genes.

166. (1) 3.4 nm
B-DNA is the most common structural form of the DNA double helix. It is characterized by a right-handed helix with a specific set of dimensions. In this form, a single complete turn, or loop, of the helix spans a distance of approximately thirty-four Angstroms, which is equivalent to three point four nanometers. This turn typically includes ten base pairs, reflecting the highly organized structure of DNA.

167. (1) both are polymer of nucleotides
Both DNA and RNA are essential biological macromolecules known as nucleic acids. Their primary structural similarity lies in the fact that they are both polymers composed of individual building blocks called nucleotides. Each nucleotide in both molecules consists of a pentose sugar, a phosphate group, and a nitrogenous base. This basic structural framework allows them to store and transmit genetic information within all living organisms.

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168. (3) semi-conservative
The semi-conservative model of DNA replication describes how the genetic information is accurately copied. During this process, the two strands of the parental DNA double helix separate from each other. Each original strand then serves as a template for the synthesis of a new, complementary strand. As a result, each of the two daughter DNA molecules contains one original parental strand and one new strand.

169. (1) tRNA
Translation relies on the accurate recognition of codons in messenger RNA by transfer RNA molecules. Each transfer RNA molecule contains a specific triplet of bases called an anticodon. This anticodon is complementary to a particular codon on the messenger RNA. Through base-pairing between the codon and the anticodon, the transfer RNA ensures that the correct amino acid is delivered to the ribosome for protein synthesis.

170. (1) L-shaped
The structure of transfer RNA can be viewed from different perspectives. While its two-dimensional folding resembles a clover leaf, its actual three-dimensional configuration is more complex. Due to further folding and tertiary interactions, the molecule assumes a compact, three-dimensional shape that is often described as L-shaped. This

133. (3) Reverse transcriptase
Reverse transcriptase is a unique enzyme primarily found in retroviruses. Unlike typical DNA polymerases that use a DNA template, reverse transcriptase uses an RNA template to synthesize a complementary DNA strand. This process, known as reverse transcription, is essential for the life cycle of these viruses, as it allows their RNA genome to be converted into DNA and integrated into the host cell's genome.

134. (3) Endonuclease
Nucleases are enzymes that break down nucleic acids by cleaving phosphodiester bonds. They are classified into two main types based on where they cut. Exonucleases remove nucleotides one at a time from the ends of a DNA or RNA molecule. Endonucleases, however, are capable of hydrolyzing internal phosphodiester bonds within a polynucleotide chain, allowing them to cut the molecule at specific internal sites.

135. (3) ribonucleoprotein
Telomerase is a specialized enzyme that maintains the ends of linear chromosomes, known as telomeres. It is a ribonucleoprotein, meaning it consists of both a protein component and an RNA molecule. The RNA component serves as a template for adding repetitive DNA sequences to the chromosome ends. This activity is crucial for preventing the gradual loss of genetic information during successive rounds of DNA replication.

136. (2) TATA box
The initiation of transcription in eukaryotic cells involves the binding of RNA polymerase and various transcription factors to the promoter region. A key sequence found within many promoters is the TATA box, which is rich in adenine and thymine bases. When the transcriptional machinery binds to this sequence, the DNA structure often undergoes a conformational change, sometimes described as assuming a saddle-like shape.

137. (3) only on plates with streptomycin
The replica plating technique is used to demonstrate that mutations can occur spontaneously and are not necessarily adaptations to the environment. By transferring bacterial colonies to plates containing an antibiotic like streptomycin, researchers can identify resistant mutants. These resistant colonies originate from cells that already possessed the mutation before they ever encountered the antibiotic, proving that the mutation was a random, pre-existing event.

138. (2) they cannot synthesise functional beta galactosidase
In the lac operon, the lac z-gene is responsible for encoding the enzyme beta-galactosidase. This enzyme is essential for the hydrolysis of lactose into its constituent sugars, glucose and galactose. If the lac z-gene is mutated and produces a non-functional enzyme, the bacterial cell cannot break down lactose. Consequently, the bacteria will be unable to grow in a medium where lactose is the only energy source.

139. (3) G + C / A + T
Erwin Chargaff discovered several important relationships regarding the base composition of DNA. While the proportions of individual bases can vary between species, certain ratios remain constant. Specifically, the ratio of the sum of guanine and cytosine to the sum of adenine and thymine is characteristic and constant for a given species. This observation was foundational for the later development of the double-helix model of DNA.

140. (4) moves in bidirectional way.
The replication of a bacterial chromosome, such as that in Escherichia coli, begins at a single, specific site called the origin of replication. From this starting point, the replication process typically proceeds in both directions simultaneously. This bidirectional movement of two replication forks allows the entire circular DNA molecule to be copied efficiently and quickly, ensuring that both daughter cells receive a complete genome.

141. (4) tRNA
Transfer RNA molecules have a distinctive and highly conserved structure that is essential for their role in protein synthesis. In a two-dimensional representation, the folding of the RNA chain creates several loops and base-paired stems, resulting in a shape that closely resembles a clover leaf. This structure includes an anticodon loop for recognizing codons and an amino acid attachment site at the end.

142. (3) UAUGC
During transcription, the RNA molecule is synthesized as a complementary copy of the DNA template strand. According to the base-

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180. (2) transposons
Most DNA sequences occupy a fixed position within a chromosome. However, some genetic elements have the remarkable ability to move or "jump" from one location to another within the genome. These mobile genetic elements are known as transposons, or transposable elements. By switching their position, transposons can cause mutations, change the amount of DNA in the genome, and play a significant role in genetic evolution.

181. (2) 5-methylcytosine
Point mutations are changes that occur at a single base pair in the DNA sequence. Certain areas of the genome, known as hotspots, are more prone to these spontaneous mutations. In many organisms, the presence of five-methylcytosine is a primary reason for these hotspots. This modified base can undergo spontaneous deamination to become thymine, which is a common source of point mutations if not corrected by repair mechanisms.

182. (4) basic protein.
In prokaryotes, the large circular DNA molecule must be highly compacted to fit within the bacterial cell. Since bacteria lack histone proteins, they use other methods for DNA packaging. The DNA is organized with the help of various basic proteins that carry positive charges. These proteins interact with the negatively charged phosphate backbone of the DNA, helping to coil and fold it into a compact nucleoid structure.

183. (1) thymidine
Researchers can measure the rate of DNA synthesis by tracking the incorporation of radioactive building blocks into new DNA strands. Thymidine is a nucleoside that is specifically used for DNA synthesis and is not present in RNA. By using radio-labelled thymidine, scientists can selectively measure how much new DNA is being produced in a cell population, providing a precise tool for studying the cell cycle and replication.

184. (2) UAG, UGA, UAA
The genetic code includes sixty-four codons, but not all of them specify amino acids. Three specific triplets act as stop signals to end the process of translation. These chain-terminating codons are UAG, UGA, and UAA. When a ribosome encounters any of these codons on a messenger RNA molecule, it stops adding amino acids and releases the completed polypeptide chain into the cell for further processing.

185. (4) tRNA.
Transfer RNA, or tRNA, plays a vital role as an adapter molecule in protein synthesis. Its primary function is to pick up specific amino acids from the cytoplasmic pool and transport them to the ribosome. Each tRNA molecule is designed to recognize a particular codon on the messenger RNA through its anticodon. This ensures that the amino acids are added to the growing polypeptide chain in the correct order.

186. (1) Peptidyl transferase reaction
Protein synthesis is an energy-intensive process that requires many high-energy phosphate bonds. Steps such as amino acid activation, the binding of aminoacyl-tRNA to the ribosomal A-site, and the translocation of the ribosome all consume energy from ATP or GTP. However, the actual formation of the peptide bond, catalyzed by the peptidyl transferase activity of the ribosome, does not directly consume an additional high-energy phosphate bond during the reaction.

187. (4) in the nucleolus as well as in the cytoplasm.
In animal cells, translation occurs on ribosomes located in various parts of the cell. While many proteins are synthesized in the cytoplasm, translation also occurs within mitochondria which have their own ribosomes. This ensures that the cell can efficiently produce the wide variety of proteins needed for its structure and function by utilizing both cytoplasmic and mitochondrial resources.

188. (3) double-helix stage
The physical structure of DNA has been investigated using various advanced scientific methods. Radiotracer techniques, which involve tracking radioactive isotopes incorporated into biological molecules, have provided important evidence regarding its form. These studies, along with X-ray diffraction data, have consistently shown that DNA exists in a double-helix structure. This structure consists of two anti-parallel strands twisted around each other, which is fundamental to how it stores and replicates genetic information.

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152. (1) Lactose
The term "lac" in the lac operon refers specifically to lactose, the sugar that serves as both a source of energy and an inducer for the system in bacteria like Escherichia coli. The operon contains a set of genes that work together to enable the cell to transport and break down lactose only when it is available in the surrounding environment for use.

153. (3) 30%
According to the rules of DNA base pairing, the amount of thymine always equals the amount of adenine. If thymine is twenty percent, then adenine is also twenty percent, totaling forty percent for the A-T pairs. The remaining sixty percent of the DNA must be composed of guanine and cytosine in equal amounts. Therefore, guanine will account for thirty percent of the total nitrogenous bases.

154. (2) Diplococcus pneumoniae
Frederick Griffith first demonstrated the process of transformation in nineteen twenty-eight. His groundbreaking experiments were conducted using the bacterium Streptococcus pneumoniae, which was formerly known as Diplococcus pneumoniae. By observing how non-virulent strains could acquire pathogenicity from heat-killed virulent strains, he discovered that a substance could be transferred between cells to change their characteristics, providing an early hint about the nature of genetic material.

155. (3) RNA ligase
RNA processing in eukaryotes involves several sophisticated steps to produce a mature messenger RNA. After the non-coding introns are removed during splicing, the remaining coding exon segments must be joined together to form a continuous sequence. This final rejoining of exons is catalyzed by the spliceosome complex, which ensures that the genetic information is correctly assembled for translation into a functional protein.

156. (1) protein
A mature messenger RNA molecule is composed of sequences that contain the actual genetic instructions for building a protein. These sequences are known as exons. During the processing of the primary RNA transcript, the non-coding introns are removed, and the exons are joined together. The resulting sequence of codons in the exons provides the template that determines the specific order of amino acids in a protein.

157. (1) degeneracy of genetic code
The genetic code is described as degenerate because there are sixty-one sense codons but only twenty standard amino acids. This means that most amino acids are specified by more than one individual codon. This redundancy provides a biological advantage, as it can minimize the harmful effects of certain point mutations in the DNA sequence, potentially allowing the same amino acid to be incorporated despite the change.

158. (2) mutation
A mutation is defined as any change that occurs in the sequence of nucleotides within a DNA molecule. These changes can range from a single base substitution to large-scale chromosomal rearrangements. Mutations are the primary source of genetic variation in a population and can be caused by various factors, including errors during DNA replication or exposure to environmental mutagens like radiation or certain chemicals.

159. (4) on ribosomes present in cytoplasm as well as in mitochondria.
In animal cells, the process of protein synthesis occurs on ribosomes, which are the cellular organelles responsible for translation. These ribosomes are found in two main locations. Many are located in the cytoplasm, either floating freely or attached to the endoplasmic reticulum. However, translation also takes place within certain semi-autonomous organelles, like mitochondria, which have their own set of ribosomes for producing specific proteins.

160. (1) all prokaryotes
The operon concept, first proposed by Jacob and Monod based on their studies of lactose metabolism in Escherichia coli, is a fundamental mechanism of gene regulation. This model describes how a cluster of genes is controlled as a single unit by a single promoter and operator. While primarily found in prokaryotic organisms, this system of coordinated gene expression is applicable to all known bacteria and archaea.

161. (2) operator gene
The regulation of the lac operon in Escherichia coli involves a repressor protein that acts as an

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198. (3) DNA gyrase
DNA replication requires the two strands of the double helix to be separated so that each can serve as a template. To manage the physical stresses and twisting that occur during this process, specific proteins are required. DNA gyrase is a type of topoisomerase that helps to open up and relax the DNA double helix in front of the replication fork, allowing the replication machinery to move forward smoothly and accurately.

199. (4) Transcription
The synthesis of a protein, or translation, is a three-step process consisting of initiation, elongation, and termination. These steps occur on the ribosome and involve the assembly of amino acids into a polypeptide chain. Transcription, however, is a separate process that takes place beforehand. It involves copying the genetic information from DNA into an RNA molecule, which then serves as the template for the actual protein synthesis process.

200. (4) lactose.
The lac operon in Escherichia coli is a regulated system that is only activated when certain conditions are met. For the operon to be induced, a specific molecule must be present to remove the inhibition caused by the repressor protein. In this system, lactose serves as the inducer. When lactose is available in the environment, it binds to the repressor, allowing the transcription of genes required for its metabolism to occur.

201. (4) H_2A, H_2B, H3 and H4.
A nucleosome is the fundamental unit of DNA packaging in eukaryotic cells. It consists of a segment of DNA wrapped around a core of histone proteins. This core is an octamer made up of two molecules each of four specific histones: H_2A, H_2B, H3, and H4. Another histone, H1, is not part of the core itself but helps to stabilize the structure by binding to the DNA at the entry and exit points.

202. (1) single stranded
Double-stranded DNA molecules follow strict base-pairing rules where the amount of purines equals the amount of pyrimidines, specifically A equals T and G equals C. If a DNA molecule is found to have unequal amounts of these nitrogenous bases, it indicates that the molecule does not follow these pairing rules. This is most probably because the DNA is single-stranded, a condition found in some types of viruses and during certain biological processes.

203. (1) X-ray crystallography
The arrangement of nucleotides and the overall structure of DNA are too small to be seen with a regular light microscope. To visualize the detailed molecular structure and the arrangement of atoms in a DNA crystal, scientists use X-ray crystallography. This technique involves beaming X-rays at a crystal and analyzing the diffraction pattern, which provided the critical evidence used by Watson and Crick to develop their double-helix model of the DNA molecule.

204. (2) DNA
Early experiments by Frederick Griffith identified a "transforming principle" that could change the hereditary characteristics of bacteria. In the nineteen forties, Avery, MacLeod, and McCarty conducted detailed biochemical research to identify this substance. By selectively destroying different components of the cell, they demonstrated that only the purified DNA from virulent Pneumococcus bacteria could transform non-virulent strains. This crucial finding established DNA as the molecule responsible for carrying genetic information.

205. (4) Hershey and Chase
While many scientists contributed to our understanding of heredity, the definitive and unequivocal proof that DNA is the basic genetic material came from the experiments of Alfred Hershey and Martha Chase in nineteen fifty-two. Using radioactive isotopes to label the components of bacteriophages, they showed that only the viral DNA enters the host bacteria to direct replication. This result finally settled the debate over whether proteins or DNA carried the genetic instructions for life.

206. (3) unwindase/helicase
DNA replication begins with the unwinding of the two strands of the double helix. This essential step is catalyzed by a group of enzymes known as helicases, or unwindases. These enzymes use energy from ATP to break the hydrogen bonds between the complementary nitrogenous bases. By separating the strands, helicases create the replication fork, providing the single-stranded templates that are necessary for DNA polymerase to synthesize new DNA strands accurately.

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Karnataka NEET 2013

58. Dinosaurs dominated the world in which of the following geological eras?
(1) Cenozoic
(2) Jurassic
(3) Mesozoic
(4) Devonian

2012

59. Which one of the following options gives one correct example each of convergent evolution and divergent evolution?

	Convergent evolution		Divergent evolution
(1)	Eyes of octopus and mammals	-	Bones of forelimbs of vertebrates
(2)	Thorns of Bougainvillea and tendrils of Cucurbita	-	Wings of butterflies and bird
(3)	Bones of forelimbs of vertebrates	-	Wings of butterfly and birds
(4)	Thorns of Bougainvillea and tendrils of Cucurbita	-	Eyes of octopus and mammals

2012

60. Evolution of different species in a given area starting from a point and spreading to other geographical areas is known as
(1) adaptive radiation
(2) natural selection
(3) migration
(4) divergent evolution.

Mains 2012

61. The idea of mutations was brought forth by
(1) Hugo de Vries who worked on evening primrose
(2) Gregor Mendel who worked on Pisum sativum
(3) Hardy-Weinberg who worked on allele frequencies in a population
(4) Charles Darwin who observed a wide variety of organisms during sea voyage.

2012, 2011

62. What was the most significant trend in the evolution of modern man (Homo sapiens) from his ancestors?
(1) Shortening of jaws
(2) Binocular vision
(3) Increasing cranial capacity
(4) Upright posture

2012

63. The extinct human who lived 1,00,000 to 40,000 years ago, in Europe, Asia and parts of Africa, with short stature, heavy eye brows, retreating fore heads, large jaws with heavy teeth, stocky bodies, a lumbering gait and stooped posture was
(1) Homo habilis
(2) Neanderthal human
(3) Cro-magnon human
(4) Ramapithecus.

Mains 2010

64. Given below are four statements (A-D) each with one or two blanks. Select the option which correctly fills up the blanks in two statements.
Statements:
(A) Wings of butterfly and birds look alike and are the results of (i) evolution.
(B) Miller showed that CH_4, H_2, NH_3 and (i) when exposed to electric discharge in a flask resulted in formation of (ii) .
(C) Vermiform appendix is a (i) organ and an (ii) evidence of evolution.
(D) According to Darwin evolution took place due to (i) and (ii) of the fittest.
(1) (D) - (i) small variations, (ii) survival, (A) - (i) convergent
(2) (A) - (i) convergent, (B) - (i) oxygen, (ii) nucleosides
(3) (B) - (i) water vapour, (ii) amino acids, (C) - (i) rudimentary, (ii) anatomical
(4) (C) - (i) vestigial, (ii) anatomical, (D) - (i) mutations, (ii) multiplication

2010, 2008

65. Darwin's finches are a good example of
(1) industrial melanism
(2) connecting link
(3) adaptive radiation
(4) convergent evolution.

Mains 2010

66. The most apparent change during the evolutionary history of Homo sapiens is traced in
(1) loss of body hair
(2) walking upright
(3) shortening of the jaws
(4) remarkable increase in the brain size

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because a doublet code would only provide sixteen combinations, which is not enough to specify all twenty standard amino acids. The sixty-four codons ensure that every amino acid can be accurately and redundantly coded for by the genetic system.

216. (2) semi-conservative and semi-discontinuous
DNA replication is a complex process with two key characteristics. It is semi-conservative, meaning each new DNA double helix contains one original parental strand and one newly synthesized strand. It is also semi-discontinuous because DNA polymerase can only synthesize in the five-prime to three-prime direction. This results in the continuous synthesis of the leading strand toward the replication fork and the discontinuous synthesis of the lagging strand in short segments away from the fork.

217. (4) all of these.
The genetic code is the set of rules by which information encoded within genetic material is translated into proteins by living cells. This code is built using the four nitrogenous bases found in nucleic acids: adenine, guanine, cytosine, and either thymine in DNA or uracil in RNA. These bases form the triplet codons that represent the twenty amino acids. Therefore, all of these bases are essential components of the genetic code system across all organisms.

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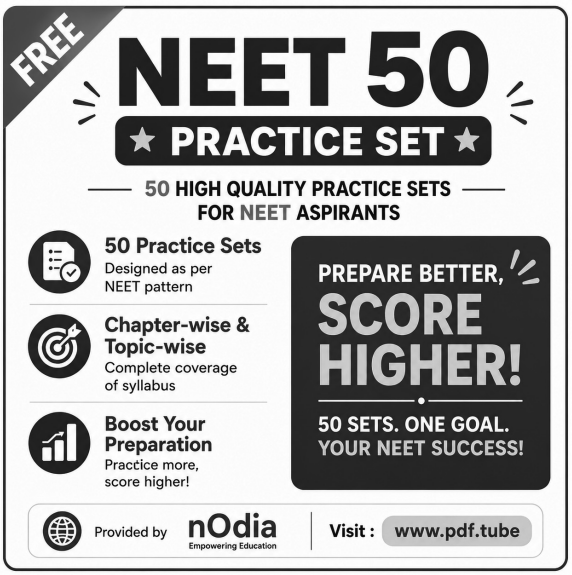

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207. (4) AUG.
Translation is the biological process of building proteins based on an RNA template. In eukaryotic cells, this process always commences at a specific site on the messenger RNA. This site is marked by the initiation codon, which is AUG. In addition to signaling the start of protein synthesis, the AUG codon also specifies the incorporation of the amino acid methionine, which serves as the first building block of the new polypeptide chain.

208. (3) degenerate
The genetic code is described as degenerate because there is more than one codon for most of the twenty standard amino acids. This redundancy means that even though each codon specifies only one amino acid, many amino acids can be brought to the ribosome by several different transfer RNA molecules with different anticodons. This property provides a level of protection against certain point mutations in the DNA, ensuring the correct protein is still produced.

209. (2) protein synthesis
In the flow of genetic information, translation is the final stage that leads to the expression of biological traits. This process occurs on the ribosomes and involves interpreting the genetic code carried by messenger RNA to assemble a specific sequence of amino acids. Therefore, translation is essentially the process of protein synthesis. It converts the information from the language of nucleic acids into the language of proteins, the workhorses of the cell.

210. (1) different density and do not resemble parent DNA
In the Meselson-Stahl experiment, bacteria were first grown in heavy nitrogen until their DNA was fully labelled. When these bacteria were transferred to a medium with normal, lighter nitrogen and allowed to divide once, the resulting first-generation DNA molecules were hybrids. These hybrid molecules contained one heavy parental strand and one new light strand. As a result, they had a density intermediate between the parental and purely light DNA, supporting semi-conservative replication.

211. (1) Escherichia coli
The study of how genetic information is copied has utilized various model organisms. The most significant insights into the mechanism of DNA replication were gained from experiments using the bacterium Escherichia coli. Its simple structure, fast growth rate, and ease of genetic manipulation made it an ideal subject. Key experiments, such as those by Meselson and Stahl, used E. coli to demonstrate the semi-conservative nature of replication, a process fundamental to all life.

NODIA

212. (2) cysteine and valine
Har Gobind Khorana was a pioneer in molecular biology who developed chemical methods to synthesize defined sequences of RNA. His work was instrumental in deciphering the genetic code. By using these synthetic RNAs in cell-free translation systems, he was able to determine which triplet codons specify particular amino acids. Among his first discoveries were the specific codons that code for the amino acids cysteine and valine, contributing to the complete mapping of the genetic code dictionary.

213. (2) transcription
The primary step in the expression of genetic information is the conversion of DNA instructions into an RNA molecule. This fundamental biological process is known as transcription. During transcription, the enzyme RNA polymerase uses one strand of DNA as a template to synthesize a complementary RNA strand. This newly formed RNA, often messenger RNA, then carries the genetic information from the genome to the ribosomes for the eventual synthesis of specific proteins.

214. (2) nucleosome
In the nucleus of eukaryotic cells, DNA is compactly organized through its interaction with a group of basic proteins called histones. A nucleosome is the primary structural unit of this organization. It is formed when a segment of the negatively charged DNA molecule wraps around a core octamer. This core consists of eight histone molecules, specifically two each of the four histone types: H_2A, H_2B, H3, and H4, creating a beads-on-a-string appearance.

215. (4) genetic code is triplet.
The genetic code uses a system of triplet codons to specify the order of amino acids in proteins. Since there are four different nitrogenous bases, there are sixty-four possible combinations of three bases. This triplet nature is essential

(1) A-III, B-IV, C-I, D-II
(2) A-I, B-II, C-III, D-IV
(3) A-II, B-IV, C-III, D-I
(4) A-II, B-IV, C-I, D-III

2026 (CANCELLED)

9. Evolution of human appears parallel to the progressive development of brain and language skills. As such, the evolution of individual species in the sequence of their appearance is:
(1) Ramapithecus → Homo habilis → Homo erectus → Neanderthal → Homo sapiens
(2) Homo sapiens → Ramapithecus → Homo habilis → Neanderthal → Homo erectus
(3) Homo habilis → Homo erectus → Ramapithecus → Neanderthal → Homo sapiens
(4) Neanderthal → Ramapithecus → Homo habilis → Homo erectus → Homo sapiens

RE-EXAM 2024

10. Match List-I with List-II.

	List-I		List-II
A.	Living fossil	I.	Elongated canine teeth
B.	Connecting link	II.	Vermiform appendix
C.	Vestigial organ	III.	Echidna
D.	Atavism	IV.	Latimeria

Choose the correct answer from the options given below.
(1) A-IV, B-III, C-II, D-I
(2) A-IV, B-II, C-III, D-I
(3) A-IV, B-III, C-I, D-II
(4) A-III, B-IV, C-I, D-II

2024

11. The flippers of the Penguins and Dolphins are the example of the
(1) adaptive radiation
(2) natural selection
(3) convergent evolution
(4) divergent evolution.

RE-EXAM 2024

12. Match List-I with List-II with respect to convergent evolution.

	List-I		List-II
A.	Lemur	I.	Flying phalanger
B.	Bobcat	II.	Numbat
C.	Anteater	III.	Spotted cuscus
D.	Flying squirrels	IV.	Tasmanian tiger cat

Choose the correct answer from the options given below.
(1) A-III, B-IV, C-II, D-I
(2) A-III, B-II, C-IV, D-I
(3) A-IV, B-III, C-II, D-I
(4) A-IV, B-II, C-III, D-I

RE-EXAM 2024

13. Which evolutionary phenomenon is depicted by the sketch given in figure?

(1) (2) (3) (4)

(1) Artificial selection
(2) Genetic drift
(3) Convergent evolution
(4) Adaptive radiation

RE-EXAM 2024

14. Match List-I with List-II.

	List-I		List-II
A.	Gene pool	I.	Stable within a generation
B.	Genetic drift	II.	Change in gene frequency by chance
C.	Gene flow	III.	Transfer of genes into or out of population
D.	Gene frequency	IV.	Total number of genes and their alleles

Choose the correct answer from the options given below.
(1) A-III, B-II, C-I, D-IV
(2) A-IV, B-II, C-III, D-I
(3) A-I, B-II, C-III, D-IV
(4) A-II, B-III, C-IV, D-I

2024

15. Which one of the following factors will not affect the Hardy-Weinberg equilibrium?
(1) Genetic recombination
(2) Genetic drift
(3) Gene migration
(4) Constant gene pool

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(2) Heart of bat, man and cheetah
(3) Brain of bat, man and cheetah
(4) Eye of octopus, bat and man

2018

36. According to Hugo de Vries, the mechanism of evolution is
(1) multiple step mutations
(2) saltation
(3) phenotypic variations
(4) minor mutations.

2017

37. Artificial selection to obtain cows yielding higher milk output represents
(1) directional as it pushes the mean of the character in one direction
(2) disruptive as it splits the population into two, one yielding higher output and the other lower output
(3) stabilising followed by disruptive as it stabilises the population to produce higher yielding cows
(4) stabilising selection as it stabilises this character in the population.

NEET-II 2016

38. Which of the following is the correct sequence of events in the origin of life?
I. Formation of protobionts
II. Synthesis of organic monomers
III. Synthesis of organic polymers
IV. Formation of DNA-based genetic systems
(1) I, II, III, IV
(2) I, III, II, IV
(3) II, III, I, IV
(4) II, III, IV, I

NEET-I 2016

39. Following are the two statements regarding the origin of life.
(A) The earliest organisms that appeared on the earth were non-green and presumably anaerobes.
(B) The first autotrophic organisms were the chemoautotrophs that never released oxygen.
Of the above statements which one of the following options is correct?
(1) Both (A) and (B) are correct.
(2) Both (A) and (B) are false.
(3) (A) is correct but (B) is false.
(4) (B) is correct but (A) is false.

NEET-I 2016

40. Which of the following structures is homologous to the wing of a bird?
(1) Hindlimb of rabbit
(2) Flipper of whale
(3) Dorsal fin of a shark
(4) Wing of a moth

NEET-I 2016

41. Analogous structures are a result of
(1) shared ancestry
(2) stabilising selection
(3) divergent evolution
(4) convergent evolution.

NEET-II 2016, 2002

42. Genetic drift operates in
(1) small isolated population
(2) large isolated population
(3) non-reproductive population
(4) slow reproductive population.

NEET-II 2016

43. In Hardy-Weinberg equation, the frequency of heterozygous individual is represented by
(1) p^2
(2) 2pq
(3) pq
(4) q^2.

NEET-II 2016

44. The chronological order of human evolution from early to the recent is
(1) Australopithecus → Ramapithecus → Homo habilis → Homo erectus
(2) Ramapithecus → Australopithecus → Homo habilis → Homo erectus
(3) Ramapithecus → Homo habilis → Australopithecus → Homo erectus
(4) Australopithecus → Homo habilis → Ramapithecus → Homo erectus

2015

45. The wings of a bird and the wings of an insect are
(1) phylogenetic structures and represent divergent evolution
(2) homologous structures and represent convergent evolution
(3) homologous structures and represent divergent evolution
(4) analogous structures and represent convergent evolution.

NODIA

2020

25. From his experiments, S.L. Miller produced amino acids by mixing the following in a closed flask.
(1) CH_4, H_2, NH_3 and water vapor at 800°C
(2) CH_3, H_2, NH_4 and water vapor at 800°C
(3) CH_4, H_2, NH_3 and water vapor at 600°C
(4) CH_3, H_2, NH_3 and water vapor at 600°C

2020

26. Which of the following refer to correct example(s) of organisms which have evolved due to changes in environment brought about by anthropogenic action?
(i) Darwin's Finches of Galapagos islands.
(ii) Herbicide resistant weeds.
(iii) Drug resistant eukaryotes.
(iv) Man-created breeds of domesticated animals like dogs.
(1) only (i)
(2) (i) and (iii)
(3) (ii), (iii) and (iv)
(4) only (iv)

2020

27. Embryological support for evolution was disapproved by
(1) Karl Ernst von Baer
(2) Alfred Wallace
(3) Charles Darwin
(4) Oparin.

2020

28. Flippers of penguins and dolphins are examples of
(1) adaptive radiation
(2) convergent evolution
(3) industrial melanism
(4) natural selection.

2019

29. Variations caused by mutation, as proposed by Hugo de Vries, are
(1) small and directionless
(2) random and directional
(3) random and directionless
(4) small and directional.

2019

30. A gene locus has two alleles A, a. If the frequency of dominant allele A is 0.4, then what will be the frequency of homozygous dominant, heterozygous and homozygous recessive individuals in the population?
(1) 0.16 (AA); 0.36 (Aa); 0.48 (aa)
(2) 0.36 (AA); 0.48 (Aa); 0.16 (aa)
(3) 0.16 (AA); 0.24 (Aa); 0.36 (aa)
(4) 0.16 (AA); 0.48 (Aa); 0.36 (aa)

2019

31. In a species, the weight of newborn ranges from 2 to 5 kg. 97% of the newborn with an average weight between 3 to 3.3 kg survive whereas 99% of the infants born with weights from 2 to 2.5 or 4.5 to 5 kg die.
Which type of selection process is taking place?
(1) Cyclical selection
(2) Directional selection
(3) Stabilising selection
(4) Disruptive selection

2019

32. Match the hominids with their correct brain size.

	Column I (Hominids)		Column II (Brain Size)
A.	Homo habilis	(i)	900cc
B.	Homo neanderthalensis	(ii)	1350 cc
C.	Homo erectus	(iii)	650-800cc
D.	Homo sapiens	(iv)	1400cc

Select the correct option.
(1) (A)-(iv); (B)-(iii); (C)-(i); (D)-(ii)
(2) (A)-(iii); (B)-(i); (C)-(iv); (D)-(ii)
(3) (A)-(iii); (B)-(ii); (C)-(i); (D)-(iv)
(4) (A)-(iii); (B)-(iv); (C)-(i); (D)-(ii)

Odisha NEET 2019

33. Which of the following statements is correct about the origin and evolution of men ?
(1) Agriculture came around 50,000 years back.
(2) The Dryopithecus and Ramapithecus primates existing 15 million years ago, walked like men.
(3) Homo habilis probably ate meat.
(4) Neanderthal men lived in Asia between 1,00,000 and 40,000 years back.

2018

34. The similarity of bone structure in the forelimbs of many vertebrates is an example of
(1) homology
(2) analogy
(3) convergent evolution
(4) adaptive radiation.

2018

35. Among the following sets of examples for divergent evolution, select the incorrect option.
(1) Forelimbs of man, bat and cheetah

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CHAPTER 25
Evolution

2026 (RE-NEET)

1. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.
Assertion A: Forelimbs of human and bats are homologous.
Reason R: Forelimbs of humans and bats have similar anatomical structure.
(1) A is true but R is false
(2) A is false but R is true
(3) Both A and R are correct and R is the correct explanation of A
(4) Both A and R are true, but R is not the correct explanation of A

2026 (RE-NEET)

2. A population of diploid organisms is at Hardy-Weinberg equilibrium. If the frequency of allele A is 0.1, the frequency of AA is:
(1) 0.10
(2) 0.99
(3) 0.01
(4) 0.02

2026 (RE-NEET)

3. Adaptive radiation in placental mammals and Australian Marsupials leading to similarity between distant species is an example of ___.
(1) founder effect
(2) genetic drift
(3) divergent evolution
(4) convergent evolution

2026 (RE-NEET)

4. Given below are two statements:
Statement I: Modern Homo sapiens arose in Australia and moved across continents.
Statement II: Homo sapiens arose around 75000 to 10000 years ago.
(1) Statement I is correct but Statement II is incorrect
(2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Both Statement I and Statement II are incorrect

2026 (RE-NEET)

5. Which of the following is not evidence for evolution?
(1) Embryological support for evolution as proposed by Ernst Heckel
(2) Divergent evolution of anatomical structures such as forelimbs
(3) Convergent evolution of traits like wings of birds and butterflies
(4) Paleontological evidence from fossil records

2026 (RE-NEET)

6. Natural selection can lead to.....
(a) stabilisation,
(b) genetic drift,
(c) directional change,
(d) disruption.
(1) (a), (b), (c) and (d)
(2) (a) and (c) only
(3) (a) only
(4) (a), (c) and (d) only

2026 (CANCELLED)

7. Which of the following is NOT an example of convergent evolution?
(1) Flippers of penguins and dolphins
(2) Eyes of octopuses and mammals
(3) Fore limbs of whales and bats
(4) Wings of butterflies and birds

NODIA

2026 (CANCELLED)

8. Match List I with List II with respect to chronology of evolution of life forms:
List I:
A. About 65 mya
B. About 500 mya
C. About 350 mya
D. About 320 mya
List II:
I. Jawless fish probably evolved
II. The dinosaurs suddenly disappeared from the earth
III. Seaweeds and few plants probably existed
IV. Invertebrates were formed and became active
Choose the correct answer from the options given below :

2015

46. Industrial melanism is an example of
(1) mutation
(2) Neo-Lamarckism
(3) Neo-Darwinism
(4) natural selection.

2015 Cancelled

47. Which of the following had the smallest brain capacity?
(1) Homo neanderthalensis
(2) Homo habilis
(3) Homo erectus
(4) Homo sapiens

2014

48. Forelimbs of cat, lizard used in walking; forelimbs of whale used in swimming and forelimbs of bats used in flying are an example of
(1) analogous organs
(2) adaptive radiation
(3) homologous organs
(4) convergent evolution.

2014

49. Which one of the following are analogous structures?
(1) Wings of bat and wings of pigeon
(2) Gills of prawn and lungs of man
(3) Thorns of Bougainvillea and tendrils of Cucurbita
(4) Flippers of dolphin and legs of horse

2014

50. In a population of 1000 individuals 360 belong to genotype AA, 480 to Aa and the remaining 160 to aa. Based on this data, the frequency of allele A in the population is
(1) 0.4
(2) 0.5
(3) 0.6
(4) 0.7.

2013

51. The process by which organisms with different evolutionary history evolve similar phenotypic adaptations in response to a common environmental challenge, is called
(1) non-random evolution
(2) adaptive radiation
(3) natural selection
(4) convergent evolution.

2013

52. The eye of octopus and eye of cat show different patterns of structure, yet they perform similar function. This is an example of
(1) analogous organs that have evolved due to convergent evolution
(2) analogous organs that have evolved due to divergent evolution
(3) homologous organs that have evolved due to convergent evolution
(4) homologous organs that have evolved due to divergent evolution.

Karnataka NEET 2013

53. The finch species of Galapagos islands are grouped according to their food sources. Which of the following is not a finch food?
(1) Carrion
(2) Insects
(3) Tree buds
(4) Seeds

2013

54. The tendency of population to remain in genetic equilibrium may be disturbed by
(1) lack of mutations
(2) lack of random mating
(3) random mating
(4) lack of migration.

2013

55. Variation in gene frequencies within populations can occur by chance rather than by natural selection. This is referred to as
(1) random mating
(2) genetic load
(3) genetic flow
(4) genetic drift.

Karnataka NEET 2013

56. Random unidirectional change in allele frequencies that occurs by chance in all populations and especially in small populations is known as
(1) migration
(2) natural selection
(3) genetic drift
(4) mutation.

Karnataka NEET 2013

57. Genetic variation in a population arises due to
(1) recombination only
(2) mutation as well as recombination
(3) reproductive isolation and selection
(4) mutations only.

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RE-EXAM 2024

16. What is the correct order (old to recent) of periods in Paleozoic era?
(1) Silurian, Devonian, Permian, Carboniferous
(2) Silurian, Devonian, Carboniferous, Permian
(3) Permian, Devonian, Silurian, Carboniferous
(4) Silurian, Carboniferous, Permian, Devonian

2024

17. Match List I with List II.

	List-I		List-II
A.	Mesozoic Era	I.	Lower invertebrates
B.	Proterozoic Era	II.	Fish and amphibia
C.	Cenozoic Era	III.	Birds and reptiles
D.	Paleozoic Era	IV.	Mammals

Choose the correct answer from the options given below.
(1) A-II, B-I, C-III, D-IV
(2) A-III, B-I, C-II, D-IV
(3) A-I, B-II, C-IV, D-III
(4) A-III, B-I, C-IV, D-II

2024

18. Given below are some stages of human evolution. Arrange them in correct sequence (Past to Recent)
A. Homo habilis
B. Homo sapiens
C. Homo neanderthalensis
D. Homo erectus
Choose the correct sequence of human evolution from the options given below.
(1) D-A-C-B (2) B-A-D-C
(3) C-B-D-A (4) A-D-C-B

2023

19. Select the correct group/set of Australian Marsupials exhibiting adaptive radiation.
(1) Mole, Flying squirrel, Tasmanian tiger cat
(2) Lemur, Anteater, Wolf
(3) Tasmanian wolf, Bobcat, Marsupial mole
(4) Numbat, Spotted cuscus, Flying phalanger

Manipur NEET 2023

20. Identify the fossil of man who showed the following characteristics.
(A) Brain capacity of 1400 cc
(B) Used hides to protect their body
(C) Buried their dead bodies
In the light of above statements, choose the correct answer from the options given below.
(1) Homo erectus
(2) Neanderthal man
(3) Homo habilis
(4) Australopithecus

NODIA

2022

21. Which of the following statement is not true?
(1) Analogous structures are a result convergent evolution.
(2) Sweet potato and potato is an example of analogy.
(3) Homology indicates common ancestry.
(4) Flippers of penguins and dolphins are a pair of homologous organs.

2022

22. Natural selection where more individual acquire specific character value other than the mean character value, leads to
(1) stabilising change
(2) directional change
(3) disruptive change
(4) random change.

2021

23. Match List-I with List-II.

	List-I		List-II
(p)	Adaptive radiation	(i)	Selection of resistant varieties due to excessive use of herbicides
(q)	Convergent evolution	(ii)	Bones of forelimbs in man and whale
(r)	Divergent evolution	(iii)	Wings of butterfly and bird
(s)	Evolution by anthropogenic action	(iv)	Darwin finches

Choose the correct answer from the options given below.
(1) (p)-(i); (q)-(iv); (r)-(iii); (s)-(ii)
(2) (p)-(iv); (q)-(iii); (r)-(ii); (s)-(i)
(3) (p)-(iii); (q)-(ii); (r)-(i); (s)-(iv)
(4) (p)-(ii); (q)-(i); (r)-(iv); (s)-(iii)

2021

24. The factor that leads to Founder effect in a population is
(1) genetic drift
(2) natural selection
(3) genetic recombination
(4) mutation.

2009

67. Peripatus is a connecting link between
(1) mollusca and echinodermata
(2) annelida and arthropoda
(3) coelenterata and porifera
(4) ctenophora and platyhelminthes.

2009

68. In the case of peppered moth (Biston betularia) the black-coloured form became dominant over the light-coloured form in England during industrial revolution. This is an example of
(1) appearance of the darker coloured individuals due to very poor sunlight
(2) protective mimicry
(3) inheritance of darker colour character acquired due to the darker environment
(4) natural selection whereby the darker forms were selected.

2008

69. Which one of the following is incorrect about the characteristics of protobionts (coacervates and microspheres) as envisaged in the abiogenic origin of life?
(1) They were partially isolated from the surroundings.
(2) They could maintain an internal environment.
(3) They were able to reproduce.
(4) They could separate combinations of molecules from the surroundings.

2008

70. Thorn of Bougainvillea and tendril of Cucurbita are examples of
(1) vestigial organs
(2) retrogressive evolution
(3) analogous organs
(4) homologous organs.

2008

71. Which one of the following pairs of items correctly belongs to the category of organs mentioned against it?
(1) Nephridia of earthworm and Malpighian tubules of cockroach - excretory organs
(2) Wings of honeybee and wings of crow - homologous organs
(3) Thorn of Bougainvillea and tendrils of Cucurbita - analogous organs
(4) Nictitating membrane and blind spot in human eye - vestigial organs

2008

72. Which one of the following scientist's name is correctly matched with the theory put forth by him?

Scientist's Name			Theory
(1)	De Vries	-	Natural selection
(2)	Mendel	-	Theory of Pangenesis
(3)	Weismann	-	Theory of continuity of germplasm
(4)	Pasteur	-	Inheritance of acquired characters

NODIA

2007

73. The concept of chemical evolution is based on
(1) interaction of water, air and clay under intense heat
(2) effect of solar radiation on chemicals
(3) possible origin of life by combination of chemicals under suitable environmental conditions
(4) crystallisation of chemicals.

2007

74. Which one of the following statements is correct?
(1) There is no evidence of the existence of gills during embryogenesis of mammals.
(2) All plant and animal cells are totipotent.
(3) Ontogeny repeats phylogeny.
(4) Stem cells are specialised cells.

2007

75. When two species of different genealogy come to resemble each other as a result of adaptation, the phenomenon is termed
(1) microevolution
(2) co-evolution
(3) convergent evolution
(4) divergent evolution.

2007

76. The Finches of Galapagos islands provide an evidence in favour of
(1) evolution due to mutation
(2) retrogressive evolution
(3) biogeographical evolution
(4) special creation.

2007

77. Adaptive radiation refers to
(1) evolution of different species from a common ancestor
(2) migration of members of a species to different geographical areas

(3) power of adaptation in an individual to a variety of environments
(4) adaptations due to geographical isolation.

2006

78. Which of the following amino acids was not found to be synthesised in Miller's experiment?
(1) Alanine
(2) Glycine
(3) Aspartic acid
(4) Glutamic acid

2006

79. An important evidence in favour of organic evolution is the occurrence of
(1) homologous and analogous organs
(2) homologous and vestigial organs
(3) analogous and vestigial organs
(4) homologous organs only.

2006

80. Which one of the following is not a living fossil?
(1) Peripatus
(2) King crab
(3) Sphenodon
(4) Archaeopteryx

2006

81. Jurassic period of the Mesozoic era is characterised by
(1) flowering plants and first dinosaurs appear
(2) gymnosperms are dominant plants and first birds appear
(3) radiation of reptiles and origin of mammal like reptiles
(4) dinosaurs become extinct and angiosperms appear.

2005

82. Which one of the following experiments suggests that simplest living organisms could not have originated spontaneously from non-living matter?
(1) Larvae could appear in decaying organic matter.
(2) Microbes did not appear in stored meat.
(3) Microbes appeared from unsterilised organic matter.
(4) Meat was not spoiled, when heated and kept sealed in a vessel.

2005

83. Which of the following is the relatively most accurate method for dating of fossils?
(1) Radio-carbon method
(2) Potassium-argon method
(3) Electron-spin resonance method
(4) Uranium-lead method

2005

84. Which one of the following phenomena supports Darwin's concept of natural selection in organic evolution?
(1) Development of transgenic animals
(2) Production of 'Dolly', the sheep by cloning
(3) Prevalence of pesticide resistant insects
(4) Development of organs from 'stem cells' for organ transplantation

2005

85. De Vries gave his mutation theory on organic evolution while working on
(1) Pisum sativum
(2) Drosophila melanogaster
(3) Oenothera lamarckiana
(4) Althea rosea.

2005

86. At a particular locus, frequency of A allele is 0.6 and that of a is 0.4. What would be the frequency of heterozygotes in a random mating population at equilibrium?
(1) 0.36
(2) 0.16
(3) 0.24
(4) 0.48

2005

87. Which of the following is not true for a species?
(1) Members of a species can interbreed.
(2) Gene flow does not occur between the populations of a species.
(3) Each species is reproductively isolated from every other species.
(4) Variations occur among members of a species.

2005

88. There are two opposing views about origin of modern man. According to one view Homo erectus in Asia were the ancestors of modern man. A study of variation of DNA however suggested African origin of modern man. What kind of observation on DNA variation could suggest this?
(1) Greater variation in Asia than in Africa
(2) Greater variation in Africa than in Asia
(3) Similar variation in Africa and Asia
(4) Variation only in Asia and no variation in Africa

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2004

89. According to Oparin, which one of the following was not present in the primitive atmosphere of the earth?
(1) Methane
(2) Oxygen
(3) Hydrogen
(4) Water vapour

2004

90. Age of fossils in the past was generally determined by radio-carbon method and other methods involve radioactive elements found in the rocks. More precise methods, which were used recently and led to the revision of the evolutionary periods for different groups of organisms, includes
(1) study of carbohydrates/proteins in fossils
(2) study of the conditions of fossilisation
(3) electron spin resonance (ESR) and fossil DNA
(4) study of carbohydrates/proteins in rocks.

2004

91. Diversification in plant life appeared
(1) due to long periods of evolutionary changes
(2) due to abrupt mutations
(3) suddenly on earth
(4) by seed dispersal.

2004

92. What kind of evidence suggested that man is more closely related with chimpanzee than with other hominoid apes?
(1) Evidence from DNA extracted from sex chromosomes only
(2) Comparison of chromosomes morphology only
(3) Evidence from fossil remains, and the fossil mitochondrial DNA alone
(4) Evidence from DNA extracted from sex chromosomes, autosomes.

2003

93. Which one of the following sequences was proposed by Darwin and Wallace for organic evolution?
(1) Overproduction, variations, constancy of population size, natural selection
(2) Variations, constancy of population size, overproduction, natural selection
(3) Overproduction, constancy of population size, variations, natural selection
(4) Variations, natural selection, overproduction, constancy of population size

2003

94. Convergent evolution is illustrated by
(1) rat and dog
(2) bacterium and protozoan
(3) starfish and cuttle fish
(4) dogfish and whale.

2003

95. Industrial melanism is an example of
(1) drug resistance
(2) darkening of skin due to smoke from industries
(3) protective resemblance with the surroundings
(4) defensive adaptation of skin against ultraviolet radiations.

2003

96. Which one of the following describes correctly the homologous structures?
(1) Organs with anatomical similarities, but performing different functions
(2) Organs with anatomical dissimilarities, but performing same function
(3) Organs that have no function now, but had an important function in ancestor
(4) Organs appearing only in embryonic stage and disappearing later in the adult

NODIA

2003

97. Darwin in his "Natural Selection Theory" did not believe in any role of which one of the following in organic evolution?
(1) Parasites and predators as natural enemies
(2) Survival of the fittest
(3) Struggle for existence
(4) Discontinuous variations

2003

98. Nicotiana sylvestris flowers only during long days and N. tabacum flowers only during short days. If raised in the laboratory under different photoperiods, they can be induced to flower at the same time and can be cross-fertilised to produce self-fertile offspring. What is the best reason for considering N. sylvestris and N. tabacum to be separate species?
(1) They cannot interbreed in nature.
(2) They are reproductively distinct.
(3) They are physiologically distinct.
(4) They are morphologically distinct.

2003

99. Random genetic drift in a population probably results from
(1) highly genetically variable individuals
(2) interbreeding within this population

12. (1) A-III, B-IV, C-II, D-I
Convergent evolution occurs when unrelated groups adapt similarly to identical environments. Placental mammals like the lemur, bobcat, anteater, and flying squirrel have corresponding marsupial counterparts in Australia. These pairs include the spotted cuscus for lemur, Tasmanian tiger cat for bobcat, numbat for anteater, and flying phalanger for flying squirrel, showing similar morphological adaptations despite their different evolutionary lineages.

13. (4) Adaptive radiation
The sketch illustrates the diversification of finch species from a common ancestral seed-eating bird on the Galapagos Islands. This process, where different species evolve in a specific geographical area starting from a single point, is called adaptive radiation. Each species developed unique beak shapes and sizes to exploit various food sources like insects and cactus seeds in different habitats.

14. (2) A-IV, B-II, C-III, D-I
The gene pool encompasses the total number of genes and their alleles in a population. Genetic drift refers to random changes in gene frequency by chance events. Gene flow involves the transfer of genes between populations through migration. Gene frequency remains relatively stable within a single generation unless specific evolutionary factors like mutation or selection occur, maintaining the genetic structure.

15. (4) Constant gene pool
Hardy-Weinberg equilibrium states that allele frequencies in a population remain constant from generation to generation in the absence of evolutionary influences. Factors such as genetic recombination, genetic drift, and gene migration disrupt this balance by introducing variations. Conversely, maintaining a constant gene pool ensures that the genetic structure of the population does not change over time, preserving the genetic equilibrium.

16. (2) Silurian, Devonian, Carboniferous, Permian
The Paleozoic era consists of several distinct geological periods representing significant evolutionary milestones. Arranged from oldest to most recent, these periods include the Silurian, Devonian, Carboniferous, and Permian. This sequence traces the development of early life from marine invertebrates and the first land plants to the rise of amphibians and reptiles before the start of the subsequent Mesozoic era.

17. (4) A-III, B-I, C-IV, D-II
Different geological eras are characterized by the dominance of specific animal groups. The Proterozoic era saw early invertebrates, while the Paleozoic era was the age of fish and amphibians. The Mesozoic era is known for birds and reptiles, including dinosaurs. Finally, the Cenozoic era represents the age of mammals, marking their radiation and dominance across various global terrestrial ecosystems.

18. (4) A-D-C-B
Human evolution involves a chronological sequence of ancestors leading to modern humans. Homo habilis appeared first as the handy man, followed by Homo erectus with an upright posture. Later, Neanderthal man emerged with a larger brain capacity and complex burial rituals. Finally, Homo sapiens developed, representing the most recent stage in the evolutionary lineage of the genus, showing advanced cognitive abilities.

19. (4) Numbat, Spotted cuscus, Flying phalanger
Australian marsupials provide a classic example of adaptive radiation within an isolated continent. From a common ancestor, various founders evolved to occupy different ecological niches. This group includes animals like the numbat, spotted cuscus, and flying phalanger. These species developed specialized traits for their respective diets and habitats, reflecting the diversification of marsupials throughout the unique and isolated Australian landscape.

20. (2) Neanderthal man
Neanderthal man lived in the Near East and Central Asia between 100,000 and 40,000 years ago. These early humans possessed a significant brain capacity of approximately 1400 cc. They exhibited complex social behaviors, such as using animal hides for protection against the cold and performing rituals like burying their dead, which indicates a high level of cultural and mental development.

21. (4) Flippers of penguins and dolphins are a pair of homologous organs.
Homologous structures indicate common ancestry and result from divergent evolution, where a shared organ evolves for different functions.

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2001

114. Similarities in organism with different genotype indicates
(1) microevolution
(2) macroevolution
(3) convergent evolution
(4) divergent evolution.

2001

115. Reason of diversity in living being is
(1) mutation
(2) long term evolutionary change
(3) gradual change
(4) short term evolutionary change.

2001

116. Forthcoming generation are less adaptive than the parental generation due to
(1) natural selection
(2) mutation
(3) genetic drift
(4) adaptation.

2001

117. Which statement is correct about centre of origin of plants?
(1) More diversity in improved variety
(2) Frequency of dominant gene is more
(3) Climatic condition more favourable
(4) None of these

2001

118. Which of the following is closest relative of man?
(1) Chimpanzee
(2) Gorilla
(3) Orangutan
(4) Gibbon

2001

119. Which of the following is correct order of the evolutionary history of man?
(1) Peking man, Homo sapiens, Neanderthal man, Cromagnon man
(2) Peking man, Heidelberg man, Neanderthal man, Cromagnon man
(3) Peking man, Neanderthal man, Homo sapiens, Cromagnon man
(4) Peking man, Neanderthal man, Homo sapiens, Heidelberg man

2000

120. Which is not a vestigial organ in man?
(1) Third molar
(2) Nails
(3) Segmental muscles of abdomen
(4) Coccyx

NODIA

2000

121. Which evidence of evolution is related to Darwin's finches?
(1) Evidences from biogeographical distribution
(2) Evidences from comparative anatomy
(3) Evidences from embryology
(4) Evidences from paleontology

2000

122. Which is the most important factor for continuity of a species from evolutionary point of view?
(1) Replication of genetic material
(2) Formation of gametes
(3) Synthesis of proteins
(4) None of these

2000

123. Homo sapiens have evolved in
(1) Paleocene
(2) Pleistocene
(3) Oligocene
(4) Holocene.

2000

124. Character which is closely related to human evolution is
(1) disappearance of tail
(2) reduction in size of jaws
(3) binocular vision
(4) flat nails.

2000

125. Who is directly related to man?
(1) Gorilla (2) Rhesus
(3) Gibbon (4) Orangutan

1999

126. Phenomenon of 'Industrial melanism' demonstrates
(1) geographical isolation
(2) reproductive isolation
(3) natural selection
(4) induced mutation.

1999

127. Which of the following are homologous organs?
(1) Wings of bird and hands of human
(2) Nails of human being and claws in animals
(3) Wings of bird and wings of insect
(4) Wings of bat and wings of cockroach

1999

128. Which one of the following statements is correct?
(1) Australopithecus is the real ancestor of modern man.
(2) Neanderthal man is the direct ancestor of Homo sapiens.

1993

154. Genetic drift is change of
(1) gene frequency in same generation
(2) appearance of recessive genes
(3) gene frequency from one generation to next
(4) none of these.

1992

155. The first organisms were
(1) chemoautotrophs
(2) chemoheterotrophs
(3) autotrophs
(4) eukaryotes.

1991

156. Which was absent in the atmosphere at the time of origin of life?
(1) NH_3
(2) H_2
(3) O_2
(4) CH_4

1991

157. Study of fossils is
(1) palaeontology
(2) herpetology
(3) saurology
(4) organic evolution.

1991

158. Correct order is
(1) Palaeozoic → Archaeozoic → Coenozoic
(2) Archaeozoic → Palaeozoic → Proterozoic
(3) Palaeozoic → Mesozoic → Coenozoic
(4) Mesozoic → Archaeozoic → Proterozoic.

1990

159. Parallelism is
(1) adaptive divergence
(2) adaptive divergence of widely separated species
(3) adaptive convergence of widely different species
(4) adaptive convergence of closely related groups.

1990

160. Basic principles of embryonic development were pronounced by
(1) Von Baer
(2) Weismann
(3) Haeckel
(4) Morgan.

1989

161. Evolution is
(1) progressive development of a race
(2) history and development of race along with variations
(3) history of race
(4) development of race.

1989

162. "Continuity of germplasm" theory was given by
(1) De Vries
(2) Weismann
(3) Darwin
(4) Lamarck.

1989

163. Theory of inheritance of acquired characters was given by
(1) Wallace
(2) Lamarck
(3) Darwin
(4) De Vries.

1989

164. 'Origin of Species' was written by
(1) Oparin
(2) Weismann
(3) Lamarck
(4) Darwin.

1988

165. Humming birds and Hawk illustrate
(1) convergent evolution
(2) homology
(3) adaptive radiation
(4) parallel evolution.

Not given

166. Sweet potato and potato represent a certain type of evolution. Select the correct combination of terms to explain the evolution.
(1) Homology, Convergent
(2) Analogy, Divergent
(3) Analogy, Convergent
(4) Homology, Divergent

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1996

141. The first domesticated animal by primitive man was
(1) cat
(2) cow
(3) dog
(4) horse.

1995

142. Which of the following isotopes is most dangerous to Homo sapiens?
(1) Phosphorus-32
(2) Strontium-90
(3) Caesium-137
(4) Iodine-131

1995

143. The change of the lighter-coloured variety of peppered moth (Biston betularia) to its darker variety (Biston carbonaria) is due to
(1) mutation
(2) regeneration
(3) genetic isolation
(4) temporal isolation.

1995

144. The homologous organs are those that show similarity in
(1) appearance
(2) function
(3) origin
(4) size.

1995

145. The presence of gill slits, in the embryos of all vertebrates, supports the theory of
(1) metamorphosis
(2) biogenesis
(3) organic evolution
(4) recapitulation.

1995

146. Which period is dubbed as the age of prokaryotic microbes?
(1) Precambrian
(2) Phanerozoic
(3) Archean
(4) Proterozoic

1994

147. The earliest fossil form, in the phylogeny of horse, is
(1) Equus
(2) Mesohippus
(3) Eohippus
(4) Merychippus.

1994

148. Which of the following is a pair of homologous organs?
(1) Pectoral fin of rohu and forelimb of horse
(2) Wings of grasshopper and wings of crow
(3) Lungs of rabbit and gills of rohu
(4) Wings of bat and wings of butterfly

1994

149. Which of the following evidences does not favour the Lamarckian concept of inheritance of acquired characters?
(1) Lack of pigment in cave-dwelling animals
(2) Melanisation in peppered moth
(3) Absence of limbs in snakes
(4) Presence of webbed toes in aquatic birds

1994

150. Which one of the following changes involved is irrelevant, in the evolution of man?
(1) Perfection of hand for tool making
(2) Change of diet from hard nuts and hard roots to soft food
(3) Loss of tail
(4) Increase in the ability to communicate with others and develop community behaviour

1993

151. Evolutionary convergence is development of
(1) common set of characters in group of different ancestry
(2) dissimilar characters in closely related groups
(3) common set of characters in closely related groups
(4) random mating.

1993

152. Theory of Natural Selection dwells on
(1) role of environment in evolution
(2) natural selection acting on favourable variations
(3) changes in gene complex resulting in heritable variations
(4) none of these.

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1993

153. Weismann cut off tails of mice generation after generation but tails neither disappeared nor shortened showing that
(1) Darwin was correct
(2) tail is an essential organ
(3) mutation theory is wrong
(4) Lamarckism was wrong in inheritance of acquired characters.

(3) constant low mutation rate
(4) large population size.

2003

100. In recent years, DNA sequences (nucleotide sequence) of mtDNA and Y chromosomes were considered for the study of human evolution, because
(1) they are small and therefore, easy to study
(2) they are uniparental in origin and do not take part in recombination
(3) their structure is known in greater detail
(4) they can be studied from the samples of fossil remains.

2002

101. There is no life on moon due to the absence of
(1) O_2 (2) water
(3) light (4) temperature.

2002

102. Which of the following are homologous organs?
(1) Wings of birds and locust
(2) Wings of birds and pectoral fins of fish
(3) Wings of bat and butterfly
(4) Legs of frog and cockroach

2002

103. Sequence of which of the following is used to know the phylogeny?
(1) mRNA (2) rRNA
(3) tRNA (4) DNA

2002

104. Which of the following is most important for speciation?
(1) Seasonal isolation
(2) Reproductive isolation
(3) Behavioural isolation
(4) Tropical isolation

2002

105. Some bacteria are able to grow in streptomycin containing medium due to
(1) natural selection
(2) induced mutation
(3) reproductive isolation
(4) genetic drift.

2002

106. In which condition, the gene ratio remains constant for any species population?
(1) Sexual selection
(2) Random mating
(3) Mutation
(4) Gene flow

2002

107. In which era reptiles were dominant ?
(1) Coenozoic era
(2) Mesozoic era
(3) Palaeozoic era
(4) Archaeozoic era

2002

108. According to fossils discovered up to present time origin and evolution of man started from
(1) France
(2) Java
(3) Africa
(4) China.

2001

109. Most abundant organic compound on earth is
(1) protein
(2) cellulose
(3) lipids
(4) steroids.

2001

110. 1st life on earth was
(1) cyanobacteria
(2) chemoheterotrophs
(3) autotrophs
(4) photoautotrophs.

2001

111. Darwin's theory of pangenesis shows similarity with theory of inheritance of acquired characters then what shall be correct according to it?
(1) Useful organs becomes strong and developed while useless organs become extinct.
(2) Size of organs increase with aging.
(3) Development of organs is due to will power.
(4) There should be some physical basis of inheritance.

2001

112. Half life period of 14C is
(1) 500 years
(2) 5000 years
(3) 50 years
(4) 5×10^4 years.

2001

113. In Lederberg's replica plating experiment what shall be used to obtain streptomycin resistant strain?
(1) Minimal medium and streptomycin
(2) Complete medium and streptomycin
(3) Only minimal medium
(4) Only complete medium

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ANSWERS

1. (3) Both A and R are correct and R is the correct explanation of A
Forelimbs of humans and bats are homologous organs (A correct) because they share the same basic anatomical structure and origin while performing different functions. This similar internal structure (R) is exactly why they are homologous, so R explains A.

2. (3) 0.01
Under Hardy-Weinberg equilibrium, the frequency of homozygous AA equals p^2, where p is the frequency of allele A.
Given, $p = 0.1$,
The frequency of $AA = (0.1)^2 = 0.01$.

3. (4) convergent evolution
Placental mammals and Australian marsupials evolved independently but developed similar forms (e.g. placental wolf and Tasmanian wolf). When distantly related organisms evolve similar features due to similar environments, it is convergent evolution.

4. (2) Statement I is incorrect but Statement II is correct
Modern Homo sapiens arose in Africa, not Australia, and then migrated across continents, so Statement I is incorrect. Pre-historic modern humans appeared during about 75000 to 10000 years ago, so Statement II is correct.

5. (1) Embryological support for evolution as proposed by Ernst Heckel
Ernst Haeckel's embryological support (the biogenetic law) was later disproved by Karl Ernst von Baer, who showed Haeckel's observations were exaggerated. Hence it is not valid evidence. Anatomical and paleontological evidences remain valid.

6. (4) (a), (c) and (d) only
Natural selection operates in three ways: stabilising (favouring the mean), directional (favouring one extreme = directional change), and disruptive (favouring both extremes). Genetic drift is a separate random process, not a type of natural selection. Hence only (a), (c) and (d) are correct.

7. (3) Fore limbs of whales and bats
The forelimbs of whales and bats are homologous organs with the same basic structure but different functions, illustrating divergent evolution. The other pairs are analogous structures performing similar functions with different origins, which is convergent evolution. Hence forelimbs of whales and bats are the exception.

8. (4) A-II, B-IV, C-I, D-III
About 65 mya dinosaurs went extinct (II). About 500 mya invertebrates formed and became active (IV). About 350 mya jawless fish probably evolved (I). About 320 mya seaweeds and a few plants existed (III). This gives the chronological match A-II, B-IV, C-I, D-III.

9. (1) Ramapithecus → Homo habilis → Homo erectus → Neanderthal → Homo sapiens
The correct evolutionary sequence begins with Ramapithecus, followed by Homo habilis, then Homo erectus, then Neanderthal man, and finally modern Homo sapiens. This order reflects the progressive increase in brain size, posture and language skills during human evolution, matching option (1).

10. (1) A-IV, B-III, C-II, D-I
Latimeria is a living fossil because it has remained unchanged for millions of years. Echidna acts as a connecting link between reptiles and mammals by laying eggs while possessing mammary glands. The vermiform appendix is a vestigial organ in humans with no significant functional role. Atavism refers to the reappearance of ancestral traits like elongated canine teeth in modern humans.

11. (3) convergent evolution
Penguins are birds and dolphins are mammals, yet both possess flippers for swimming. These structures have different anatomical origins but perform similar functions due to similar environmental pressures. This phenomenon is known as convergent evolution, where unrelated species develop analogous structures to adapt to a common aquatic lifestyle and shared ecological niches. It demonstrates how nature finds similar functional solutions.

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(3) Homo erectus is the ancestor of man.
(4) Cro-magnon man's fossil has been found in Ethiopia.

1998

129. The diversity in the type of beaks of finches adapted to different feeding habits on the Galapagos Islands, as observed by Darwin, provides evidence for
(1) intraspecific competition
(2) interspecific competition
(3) origin of species by natural selection
(4) intraspecific variations.

1998

130. Species occurring in different geographical area are called as
(1) sympatric (2) allopatric
(3) sibling (4) neopatric.

1998

131. In the developmental history of mammalian heart, it is observed that it passes through a two chambered fish like heart, three chambered frog like heart and finally four chambered stage. To which hypothesis can this above cited statement be approximated?
(1) Lamarck's principle
(2) Mendelian principles
(3) Biogenetic law
(4) Hardy-Weinberg law

1998

132. Genetic drift operates only in
(1) larger populations
(2) Mendelian populations
(3) island populations
(4) smaller populations.

1998

133. The age of the fossil of Dryopithecus on the geological time scale is
(1) 2.5 x 10^6 years back
(2) 50 x 10^6 years back
(3) 75 x 10^6 years back
(4) 25 x 10^6 years back.

1997

134. Evolutionary convergence is characterised by
(1) development of dissimilar characteristics in closely related groups
(2) development of a common set of characteristics in groups of different ancestry
(3) development of characteristics by random mating
(4) replacement of common characteristics in different groups.

1997

135. Which of the following statements is correct regarding evolution of mankind?
(1) Homo erectus is preceded by Homo habilis.
(2) Neanderthal man and cro-magnon man were living at the same time.
(3) Australopithecus was living in Australia.
(4) None of these

1997

136. Common origin of man and chimpanzee is best shown by
(1) binocular vision
(2) chromosome number
(3) dental formula
(4) cranial capacity.

1996

137. The correct sequence for the manufacture of molecules/organic compounds on the primitive earth is
(1) NH_3, nucleic acid, protein and carbohydrate
(2) protein, carbohydrate, water and nucleic acid
(3) NH_3, protein, carbohydrate and nucleic acid
(4) NH_3, water, nucleic acid and protein.

1996

138. Which of the following is the correct group of vestigial organs in man?
(1) Nictitating membrane, ear muscles, eyelids and coccyx
(2) Appendix, coccyx, ear muscles and elbow joint
(3) Wisdom tooth, coccyx, body hair and ear muscles
(4) Wisdom tooth, body hairs, nictitating membrane and vermiform appendix

1996

139. Which of the following changes for man in the course of evolution is probably useless?
(1) Development of being erect
(2) Development of cranial capacity
(3) Loss of tail
(4) Development of opposable thumb

1996

140. Which of the following is the direct ancestor of Homo sapiens?
(1) Australopithecus
(2) H. sapiens neanderthals
(3) Homo erectus
(4) Homo sapiens fossilis

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Conversely, analogous structures arise from convergent evolution, serving similar functions despite different origins. Flippers of penguins and dolphins are analogous, not homologous, because they represent different anatomical modifications for swimming in unrelated groups like birds and mammals, adapted to the same environment.

22. (2) directional change
Natural selection can change the distribution of traits in a population in different ways. When selection pressure favors individuals with traits at one extreme of the distribution, the mean character value shifts. This process is called directional selection. It results in the population moving toward a new phenotype that is better suited to changing environmental conditions or new selective pressures.

23. (2) (iv) (iii) (ii) (i)
Adaptive radiation is seen in Darwin finches diversifying from a common ancestor. Convergent evolution is illustrated by analogous structures like the wings of butterfly and bird. Divergent evolution is evident in homologous organs like the forelimb bones of man and whale. Anthropogenic action drives evolution through the selection of resistant varieties due to the excessive and frequent use of herbicides.

24. (1) genetic drift
The founder effect occurs when a small group of individuals becomes isolated from a larger population to start a new colony. This new population carries only a fraction of the original genetic diversity. This phenomenon is a specific form of genetic drift, where chance events significantly alter allele frequencies, potentially leading to the emergence of a new species through genetic isolation.

25. (1) CH_4, H_2, NH_3 and water vapor at 800°C
In 1953, S.L. Miller conducted an experiment to simulate primitive Earth conditions. He created an electric discharge in a closed flask containing methane, hydrogen, ammonia, and water vapor. By maintaining the temperature at 800 degrees Celsius, he successfully observed the formation of simple amino acids. This provided experimental evidence supporting the chemical evolution theory for the abiotic origin of life.

26. (3) (2), (3) and (4)
Human activities significantly influence the evolutionary trajectory of various organisms. The widespread use of herbicides has led to the emergence of resistant weed varieties. Similarly, the use of antibiotics has resulted in drug-resistant eukaryotic microbes. Domesticated animal breeds, such as diverse dog varieties, have also been created through selective breeding, which is a form of human-driven evolutionary change via selection.

27. (1) Karl Ernst von Baer
Ernst Haeckel proposed the biogenetic law, suggesting that embryos pass through adult stages of their ancestors. However, this embryological support for evolution was carefully examined and subsequently disapproved by Karl Ernst von Baer. He noted that embryos do not typically pass through the adult stages of other animals; instead, they share common embryonic features that diverge as they develop into adults.

28. (2) convergent evolution
Penguins are flightless birds and dolphins are aquatic mammals. Both have developed flippers to navigate and swim efficiently in their shared water environment. Although these flippers serve the same function, they have different anatomical origins and underlying structures. This is a classic example of convergent evolution, where unrelated species independently evolve similar traits to adapt to comparable and shared ecological niches.

29. (3) random and directionless
Hugo de Vries proposed the mutation theory based on his observations of the evening primrose. He suggested that evolution occurs through sudden, large changes rather than the gradual variations described by Darwin. According to his theory, these mutations are random and directionless. This contrast with Darwinian variations, which are small and directional, emphasizes the role of saltation in the evolutionary process.

30. (4) 0.16 (AA); 0.48 (Aa); 0.36 (aa)
In Hardy-Weinberg equilibrium, the sum of allele frequencies is one. If the dominant allele frequency is 0.4, the recessive allele frequency is 0.6. Squaring these gives the homozygous dominant frequency as 0.16 and the homozygous recessive frequency as 0.36. The heterozygous frequency is calculated as twice the product of

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both allele frequencies, which equals 0.48 in this specific population.

31. (3) Stabilising selection
Natural selection that favors intermediate phenotypes while acting against extreme variations is known as stabilising selection. In this scenario, infants with average birth weights between 3 to 3.3 kg have the highest survival rates. Those at the extremes, being very light or very heavy, face significantly higher mortality. This process maintains the mean character value and reduces phenotypic variation.

32. (4) (iii) (iv) (i) (ii)
Different hominid species are characterized by their specific cranial capacities. Homo habilis had a brain size between 650 and 800 cc. Homo erectus possessed a larger brain of about 900 cc. Neanderthal man had a significantly bigger capacity at 1400 cc. Modern humans, Homo sapiens, typically have a brain size of approximately 1350 cc, reflecting the complex evolution of the brain.

33. (4) Neanderthal men lived in Asia between 1,0,000 and 40,000 years back.
Neanderthal man represents an important stage in human prehistory. They inhabited the Near East and Central Asia roughly 100,000 to 40,000 years ago. These hominids were known for their robust build and significant brain capacity. They developed cultural practices such as using animal skins for clothing and burying their deceased, showing a high level of social and mental complexity.

34. (1) homology
The forelimbs of different vertebrates, such as humans, bats, and whales, share a similar basic skeletal pattern. This structural similarity exists despite these limbs performing vastly different functions like grasping, flying, or swimming. Such structures are called homologous organs and provide strong evidence for homology. They indicate that these diverse animals evolved from a common ancestor through the process of divergent evolution.

35. (4) Eye of octopus, bat and man
Divergent evolution involves structures with a common origin that adapt to different functions. The forelimbs, hearts, and brains of mammals like humans, bats, and cheetahs are homologous and demonstrate this process. However, the eye of an octopus and the vertebrate eye have different developmental origins despite performing similar functions. Therefore, they represent convergent evolution and are considered analogous structures rather than homologous.

36. (2) saltation
Hugo de Vries formulated the mutation theory of evolution after studying the evening primrose. He believed that new species arise not from small, continuous variations but through large, single-step mutations. He termed this process saltation. This perspective shifted the focus from Darwinian gradualism to the idea that significant genetic changes can occur abruptly, providing the primary raw material for evolutionary advancement.

37. (1) directional as it pushes the mean of the character in one direction
Artificial selection is used by humans to favor specific traits in domestic animals. In the case of increasing milk yield in cows, breeders select individuals that produce the highest output. This pushes the average milk production of the entire population toward one extreme over several generations. This type of selection is known as directional selection, as it favors a specific phenotypic shift.

38. (3) II, III, I, IV
The origin of life involved a progression from simple to complex molecules. First, organic monomers were synthesized under primitive Earth conditions. These monomers then linked to form organic polymers. Subsequently, these polymers aggregated into protobionts, which were precursors to living cells. Finally, DNA-based genetic systems developed, allowing for accurate replication and the emergence of the first true living organisms with heredity.

39. (1) Both (A) and (B) are correct.
Scientific evidence suggests that the earliest life forms on Earth were anaerobic and non-green, obtaining energy from organic molecules. As these resources became scarce, the first autotrophs emerged. These were chemoautotrophs, which utilized chemical energy rather than light. Unlike later photoautotrophs, these organisms did not release oxygen into the atmosphere, maintaining the reducing nature of the environment during that early period.

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40. (2) Flipper of whale
Homologous structures share a common anatomical origin and basic skeletal structure, even if they serve different purposes. The wing of a bird and the flipper of a whale are both modifications of the vertebrate forelimb. They contain similar bone arrangements, including the humerus, radius, and ulna. This homology indicates that birds and whales share a common tetrapod ancestor despite their different habitats.

41. (4) convergent evolution.
Analogous structures are body parts that perform similar functions in unrelated organisms but have different evolutionary origins. These structures arise when different species occupy similar environments and face comparable selection pressures. This phenomenon is known as convergent evolution. It leads to independent adaptations that look or function alike, such as the wings of insects and birds, despite lacking a recent common ancestor.

42. (1) small isolated population
Genetic drift is the random change in allele frequencies within a population due to chance events. This process is most significant and impactful in small, isolated populations where individual births or deaths can disproportionately affect the overall gene pool. In large populations, these random fluctuations are usually balanced out, making genetic drift a primary driver of evolutionary change specifically in smaller groups.

43. (2) 2pq
The Hardy-Weinberg equation provides a mathematical model for allele frequencies in a stable population. It is expressed as p squared plus 2pq plus q squared equals one. In this formula, p and q represent the frequencies of the dominant and recessive alleles. The term 2pq specifically represents the frequency of heterozygous individuals, while p squared and q squared represent the homozygotes.

44. (2) Ramapithecus → Australopithecus → Homo habilis → Homo erectus
The evolutionary timeline of humans is marked by several key ancestral stages. Ramapithecus is considered one of the earliest hominids, followed by Australopithecus, which exhibited more human-like characteristics. The lineage then progressed to Homo habilis, known for tool use, and subsequently to Homo erectus, which had a larger brain and upright posture. This chronological sequence traces the gradual development toward humans.

45. (4) analogous structures and represent convergent evolution.
The wings of birds and insects both serve the function of flight, allowing these animals to navigate their environments. However, they have completely different anatomical structures and embryonic origins. These are known as analogous structures. They result from convergent evolution, where unrelated species independently evolve similar adaptations in response to similar environmental challenges and selection pressures, rather than inheriting them from ancestors.

46. (4) natural selection.
Industrial melanism in the peppered moth is a classic demonstration of natural selection. Before the industrial revolution, light-colored moths were better camouflaged. As soot blackened the trees, dark-colored moths gained a survival advantage against predators. Over time, the frequency of the dark phenotype increased in the population. This change illustrates how environmental shifts drive the selection of favorable genetic traits over time.

47. (2) Homo habilis
Among the various stages of human evolution, brain size has generally increased over time. Homo habilis, often called the handy man, had a relatively small cranial capacity, ranging from 650 to 800 cc. This is significantly smaller than the brain capacities of later hominids like Homo erectus, Neanderthal man, and modern Homo sapiens, making it the most primitive in volume.

48. (3) homologous organs
The forelimbs of cats, lizards, whales, and bats all share a common fundamental skeletal structure, including the same basic arrangement of bones. Despite these limbs being adapted for walking, swimming, or flying, their shared anatomical origin indicates they are homologous organs. This similarity provides evidence for divergent evolution, where a common ancestral structure was modified over time to perform specialized functions.

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49. (1) Wings of bat and wings of pigeon
Analogous structures perform similar functions but have different evolutionary origins and internal designs. The wings of a bat and the wings of a pigeon both enable flight. However, a bat wing is a skin membrane supported by elongated fingers, while a pigeon wing is made of feathers attached to the forearm. This functional similarity resulting from convergent evolution highlights their different lineages.

50. (3) 0.6
To find the frequency of allele A in a population, we consider both homozygous and heterozygous individuals. There are 360 AA individuals and 480 Aa individuals in a population of 1000. Each AA individual has two A alleles, and each Aa has one. Total A alleles equal 720 plus 480, totaling 1200. Dividing by the total 2000 alleles gives 0.6.

51. (4) convergent evolution.
Convergent evolution occurs when organisms from different evolutionary backgrounds develop similar phenotypic traits. This happens because they face similar environmental challenges or occupy similar ecological niches, requiring comparable adaptations for survival. Despite having no recent common ancestor, these species evolve analogous structures that look or function alike. This process demonstrates how nature selects similar solutions for the same problems across lineages.

52. (1) analogous organs that have evolved due to convergent evolution
The eyes of an octopus and a cat serve the same function of vision but have distinct structural patterns and developmental origins. This indicates they are analogous organs rather than homologous ones. Their similarity is a result of convergent evolution, where different lineages independently evolved efficient light-sensing organs to thrive in their respective environments. It shows how similar functional needs drive evolution.

53. (1) Carrion
Darwin finches on the Galapagos Islands evolved various beak shapes to exploit different food sources. These sources include seeds, insects, tree buds, and even cactus fruits. However, carrion is not a food source for these finches. The diversification of their beaks allowed them to occupy various ecological niches and reduce competition, which is a prime example of adaptive radiation and selection.

54. (2) lack of random mating
According to the Hardy-Weinberg principle, allele frequencies in a population remain stable under specific conditions. This genetic equilibrium can be disturbed by factors that introduce new variations or change allele distributions. Lack of random mating, such as assortative mating or inbreeding, alters genotype frequencies. Other factors like mutations, gene flow, and natural selection also disrupt this balance, leading to evolutionary changes.

55. (4) genetic drift.
Genetic drift refers to the fluctuation of gene frequencies in a population due to random chance events rather than natural selection. This process can lead to the loss of certain alleles or the fixation of others, regardless of whether they are beneficial. It is particularly influential in small populations where chance occurrences can significantly impact the overall genetic makeup and contribute evolution.

56. (3) genetic drift
Genetic drift involves random changes in allele frequencies that occur by chance. While it happens in all populations, its effects are most pronounced and observable in small populations. In these groups, the accidental death or reproductive success of a few individuals can significantly alter the gene pool. This stochastic process is a key mechanism of evolution, distinct from natural selection.

57. (2) mutation as well as recombination
Genetic variation is essential for evolution and arises from two primary sources. Mutations provide new genetic material by changing DNA sequences. Recombination occurs during meiosis, shuffling existing alleles to create new combinations in offspring. Together, these processes ensure that individuals in a population are genetically diverse. This diversity provides the raw material upon which natural selection acts, allowing populations to adapt properly.

58. (3) Mesozoic
The Mesozoic Era is famously known as the Age of Reptiles because dinosaurs were the dominant land animals during this time. This era is divided into the Triassic, Jurassic, and

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Cretaceous periods. Dinosaurs flourished and diversified extensively across these periods before going extinct at the end of the Cretaceous. Their dominance defined the terrestrial ecosystems of the Mesozoic for millions of years.

59. (1) Eyes of octopus and mammals | Bones of forelimbs of vertebrates
The eyes of octopuses and mammals are analogous structures serving similar functions with different origins, illustrating convergent evolution. Conversely, the bones in the forelimbs of vertebrates, like humans and whales, share a common skeletal pattern but serve different purposes. These homologous structures are evidence of divergent evolution, where a shared ancestral trait branched out to adapt to various lifestyles and roles.

60. (1) adaptive radiation
Adaptive radiation is an evolutionary process where various species originate from a common ancestor and diversify into different ecological niches. This often occurs when a group enters a new geographical area with diverse habitats. Starting from a single point, the organisms adapt to their specific environments, leading to the formation of new species with distinct traits, as seen in Darwin finches.

61. (1) Hugo de Vries who worked on evening primrose
Hugo de Vries introduced the concept of mutations after conducting extensive breeding experiments with the evening primrose, Oenothera lamarckiana. He proposed that evolution occurs through sudden, large genetic changes rather than the slow, gradual variations suggested by Darwin. His work highlighted the importance of discrete genetic shifts as a primary source of variation, which he believed could lead to the formation of species.

62. (3) Increasing cranial capacity
Throughout the evolution of the genus Homo, several physical changes occurred, but the most significant trend was the substantial increase in cranial capacity. This growth in brain size is closely associated with enhanced cognitive abilities, complex tool-making, and the development of sophisticated social behaviors. Starting from early ancestors like Australopithecus, the brain volume expanded progressively, reaching its peak in modern Homo sapiens.

63. (2) Neanderthal human
Neanderthal humans were a distinct group of early humans who lived approximately 100,000 to 40,000 years ago. They were characterized by a brain capacity of 1400 cc and used animal hides to protect their bodies. They inhabited regions across the Near East and Central Asia and were adapted to cold climates. Their physical features and archaeological evidence suggest they were skilled hunters who practiced social rituals.

64. (1) (D) - (i) small variations, (ii) survival, (A) - (i) convergent
Darwin theory of evolution emphasizes that small, heritable variations lead to the survival of the fittest. These variations allow individuals to better adapt to their environment. Additionally, the wings of butterflies and birds serve as an example of convergent evolution. Although they have different structural origins, they evolved similar functions for flight in response to comparable environmental pressures, demonstrating functional convergence.

65. (3) adaptive radiation
Darwin finches are a classic example of adaptive radiation on the Galapagos Islands. From a single ancestral seed-eating species, several new species evolved to exploit different food sources, such as insects, cactus, and various seeds. Each species developed a unique beak shape suited to its diet. This diversification within a restricted geographical area illustrates how natural selection drives species formation.

66. (4) remarkable increase in the brain size
In the evolutionary history of Homo sapiens, the most notable and apparent physical change is the significant increase in brain size. This expansion of the cranial capacity allowed for the development of higher intelligence, complex language, and advanced problem-solving skills. While other changes like bipedalism and jaw reduction were also important, the remarkable growth of the brain defines the human lineage.

67. (2) annelida and arthropoda
Peripatus is a unique organism that serves as a connecting link between the phyla Annelida and Arthropoda. It exhibits characteristics of both groups, such as a segmented body and nephridia like annelids, while also having a tracheal respiratory system and jointed legs typical of arthropods. The existence of such organisms

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provides valuable evidence for the evolutionary transitions between different groups.

68. (4) natural selection whereby the darker forms were selected.
The case of the peppered moth during the industrial revolution in England illustrates natural selection in action. As industrial soot darkened tree trunks, the black-colored moths became better camouflaged than the light-colored ones. Consequently, birds preyed more heavily on the visible light moths, allowing the darker form to survive and reproduce more successfully. This shifted the population color dominance.

69. (3) They were able to reproduce.
Protobionts, such as coacervates and microspheres, were early molecular aggregates considered precursors to life. They could maintain an internal environment and were partially isolated from their surroundings by a boundary. They were also able to separate specific molecules from the environment. Crucially, these molecular capsules were able to reproduce their molecules, representing a significant step toward the first cellular forms of life.

70. (4) homologous organs.
The thorns of Bougainvillea and the tendrils of Cucurbita are examples of homologous organs. Although they perform very different functions, both structures originate from the axillary bud of the plant. This shared anatomical origin indicates that they have evolved from a common ancestral structure through divergent evolution, where the same basic organ was modified to serve different environmental and ecological needs.

71. (1) Nephridia of earthworm and Malpighian tubules of cockroach - excretory organs
Nephridia in earthworms and Malpighian tubules in cockroaches are both specialized structures used for excretion. While they belong to different phyla, they serve the same primary function of removing nitrogenous wastes and maintaining osmoregulation. This classification groups them correctly as excretory organs. Other pairs mentioned have different origins despite having similar functions, making them analogous rather than homologous structures.

72. (3) Weismann - Theory of continuity of germplasm
August Weismann is correctly associated with the Theory of Continuity of Germplasm. He proposed that hereditary information is carried only by the germ cells in the gonads, not by somatic cells. This theory challenged Lamarckism by stating that changes acquired during life cannot be passed to the next generation. His experiments, such as cutting mice tails, supported this specific concept.

73. (3) possible origin of life by combination of chemicals under suitable environmental conditions
The concept of chemical evolution suggests that life originated through the formation of complex organic molecules from simpler inorganic ones. This process occurred under the unique environmental conditions of the primitive Earth, which included a reducing atmosphere and high energy sources like lightning. Over time, these chemicals combined to form the first living systems, providing a scientific explanation for life origin.

74. (3) Ontogeny repeats phylogeny.
The phrase ontogeny repeats phylogeny summarizes the biogenetic law, which suggests that the embryonic development of an organism mirrors the evolutionary history of its species. For example, vertebrate embryos temporarily possess gill slits similar to those in fish ancestors. While this theory has been refined, the observation of shared embryonic stages across different groups remains a significant piece of evidence.

75. (3) convergent evolution.
Convergent evolution occurs when two species from different backgrounds evolve similar traits. This happens because they adapt to similar environmental pressures, requiring comparable functional solutions for survival. Despite having no recent common ancestor, these organisms develop analogous structures that look or function alike. This phenomenon demonstrates how natural selection can independently produce similar adaptations in diverse lineages occupying similar ecological niches.

76. (3) biogeographical evolution
Darwin finches on the Galapagos Islands provide strong evidence for biogeographical evolution. These birds diversified into various species from

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a common mainland ancestor to inhabit different islands with unique environments. This process shows how geographical isolation and different ecological pressures lead to the formation of new species. Their distribution and specialized beak shapes reflect how life adapts to specific island locations.

77. (1) evolution of different species from a common ancestor
Adaptive radiation is an evolutionary process where many different species evolve from a single common ancestor. This typically occurs when a lineage enters a new environment with various unoccupied ecological niches. Each new species adapts to its specific habitat and resources, leading to a wide variety of forms and functions. Examples include the diversification of finches on the Galapagos Islands.

78. (4) Glutamic acid
Stanley Miller 1953 experiment simulated primitive Earth conditions to test the origin of organic molecules. By applying an electric discharge to a mixture of gases, he produced several simple amino acids, including glycine, alanine, and aspartic acid. However, glutamic acid was not among the products found in his original experiment. His results were groundbreaking, proving life building blocks could form.

79. (2) homologous and vestigial organs
Significant evidence for organic evolution comes from studying body structures. Homologous organs share a common anatomical origin but perform different functions, indicating divergent evolution from a common ancestor. Vestigial organs are non-functional remnants of structures that were functional in ancestors. Together, these provide clear proof of biological change over time. While analogous organs show convergence, homologous structures directly point to ancestry.

80. (4) Archaeopteryx
Living fossils are surviving species that have remained virtually unchanged for millions of years, such as the king crab, Peripatus, and Sphenodon. These organisms provide a glimpse into the ancient past. However, Archaeopteryx is not a living fossil; it is an extinct genus of bird-like dinosaurs that lived during the Jurassic period, serving as a classic transitional fossil for birds.

81. (2) gymnosperms are dominant plants and first birds appear
The Jurassic period of the Mesozoic era is often referred to as the age of gymnosperms, as these plants were the dominant vegetation. During this time, dinosaurs reached their peak diversity and size. Crucially, the Jurassic also witnessed the emergence of the first birds, which evolved from small theropod dinosaurs. This period marks a significant stage in vertebrate radiation.

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82. (4) Meat was not spoiled, when heated and kept sealed in a vessel.
Louis Pasteur swan-neck flask experiment definitively disproved the theory of spontaneous generation. He showed that when meat or organic broth was heated to kill existing microbes and kept sealed in a vessel, no new life appeared. This demonstrated that life only arises from pre-existing life. His findings replaced the old idea that simple organisms could form spontaneously from non-living matter.

83. (3) Electron-spin resonance method
Electron-spin resonance (ESR) is a highly accurate method for dating fossils and minerals. It works by measuring the amount of trapped electrons that have accumulated in a sample over time due to natural radiation. Unlike radio-carbon dating, which is limited to relatively recent remains, ESR can date much older samples, including tooth enamel. This makes it a crucial dating tool.

84. (3) Prevalence of pesticide resistant insects
The prevalence of pesticide-resistant insects is a powerful contemporary example of natural selection. When a pesticide is applied, most insects die, but those with a rare genetic resistance survive. These resistant individuals then reproduce, passing the trait to their offspring. Over generations, the entire population becomes resistant. This demonstrates how environmental pressures select for favorable traits leading to evolutionary changes.

85. (3) Oenothera lamarckiana
Hugo de Vries developed his mutation theory while conducting experiments on the evening primrose, scientifically known as Oenothera lamarckiana. He observed sudden, large phenotypic changes in the plants that were then inherited by the next generation. These observations led him to conclude that evolution proceeds through

species form. It prevents members of different populations from interbreeding and exchanging genes. Once gene flow is stopped, populations can accumulate genetic differences independently through mutation and selection. Over time, these differences become so great that the populations can no longer produce fertile offspring together in nature.

105. (1) natural selection
The ability of some bacteria to grow in a medium containing streptomycin is a result of natural selection. In any bacterial population, rare mutations may occur that provide resistance to certain antibiotics. When streptomycin is present, only these resistant individuals survive and reproduce. This process quickly leads to a population dominated by resistant strains, demonstrating how environmental pressures favor genetic variants.

106. (2) Random mating
According to the Hardy-Weinberg principle, allele and genotype frequencies in a population will remain constant from generation to generation if specific conditions are met. One of these essential conditions is random mating, where every individual has an equal chance of mating with any other individual. This ensures that alleles are mixed thoroughly in the gene pool, preventing shifts in frequency.

107. (2) Mesozoic era
The Mesozoic era is widely recognized as the age of reptiles because they were the dominant and most diverse group of vertebrates on Earth during this time. This era, which includes the Triassic, Jurassic, and Cretaceous periods, saw the rise of dinosaurs and large marine reptiles. These animals occupied almost every ecological niche before the major extinction event at the end.

108. (3) Africa
Extensive fossil evidence discovered to date strongly suggests that the origin and early evolution of the human lineage took place in Africa. Key fossils of early hominids like Australopithecus and early members of the genus Homo have been found in African regions. This Out of Africa theory is further supported by genetic studies showing high diversity in African populations.

109. (2) cellulose
Cellulose is the most abundant organic compound on Earth. It is a complex carbohydrate that serves as the primary structural component of the cell walls in green plants, algae, and some other organisms. Due to the massive global biomass of plant life, cellulose is produced in enormous quantities annually. Its strength and durability are essential for maintaining the structure of plants.

110. (2) chemoheterotrophs
The first life forms on Earth are believed to have been chemoheterotrophs. These primitive organisms lived in the primordial soup of the early oceans and obtained their energy by breaking down organic molecules that had formed through chemical evolution. Since the atmosphere lacked free oxygen, they were also anaerobic. Autotrophs and oxygen-releasing cyanobacteria evolved much later as environmental conditions eventually changed.

111. (4) There should be some physical basis of inheritance.
Darwin theory of pangenesis proposed that every part of the body produces tiny particles called gemmules that carry hereditary information to the gametes. This idea suggests that there must be some physical basis of inheritance, where actual units of matter transmit traits. While this specific theory was later replaced, it shared with Lamarckism the concept that physical states influence inherited characters.

112. (2) 5000 years
Carbon-14 is a radioactive isotope used in radiocarbon dating to determine the age of organic materials. It has a half-life of approximately 5,730 years, which is often rounded to about 5,000 years in general contexts. This means that half of the original amount of Carbon-14 in a sample will decay over this period. This half-life makes it ideal for dating remains.

113. (2) Complete medium and streptomycin
In Lederberg's replica plating experiment, a master plate of bacteria is copied onto new plates using a velvet stamp. To specifically isolate streptomycin-resistant strains, researchers must use a medium that contains the antibiotic streptomycin. Only the rare mutant bacteria that already possess resistance will be able to grow on

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95. (3) protective resemblance with the surroundings
Industrial melanism is an excellent example of natural selection resulting in protective resemblance with the surroundings. In polluted industrial areas, dark-colored peppered moths became more common because they were better camouflaged against soot-covered trees, making them less visible to birds. This shift in the moth population directly reflects how environmental changes can favor specific phenotypes that provide a distinct survival advantage.

96. (1) Organs with anatomical similarities, but performing different functions
Homologous structures are organs or body parts that share a similar basic anatomical plan and developmental origin because they were inherited from a common ancestor. While these structures are structurally similar, they may perform vastly different functions in different species, such as bird wings and human forelimbs. This structural correspondence provides significant evidence for divergent evolution, showing modification of an ancestral trait.

97. (4) Discontinuous variations
Charles Darwin theory of natural selection primarily focused on small, continuous variations within a population as the raw material for evolution. He believed that these gradual changes accumulated over long periods to produce new species. Darwin did not recognize the importance of large, sudden, or discontinuous variations, which are now known as mutations. Later scientists, like Hugo de Vries, emphasized these.

98. (1) They cannot interbreed in nature.
Nicotiana sylvestris and N. tabacum are considered separate species primarily because they do not interbreed in nature. Their different flowering times—one during long days and the other during short days—create a seasonal isolation that prevents natural cross-fertilization. Although they can produce fertile offspring in a laboratory setting, their reproductive isolation in the wild maintains them as distinct biological units.

99. (4) large population size.
Random genetic drift refers to the fluctuation of allele frequencies in a population due to chance events. While it can occur in any population, its effects are most significant in small populations. In very large populations, genetic drift is minimal because the random success or failure of individuals does not significantly impact the overall gene pool. Constant low mutation rates actually help stability.

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100. (2) they are uniparental in origin and do not take part in recombination
Mitochondrial DNA and the Y chromosome are particularly useful for studying human evolution because they are inherited uniparentally. mtDNA is passed only from mothers to offspring, while the Y chromosome is passed only from fathers to sons. Since these genetic materials do not undergo recombination, changes occur only through mutation. This allows researchers to trace direct maternal and paternal lineages back.

101. (2) water
The absence of life on the moon is primarily due to the lack of liquid water. Water is the fundamental solvent required for all known biological processes and chemical reactions essential for life. While other factors like the absence of an atmosphere also make the moon inhospitable, the complete lack of accessible water is the most critical barrier to living organisms existence.

102. (2) Wings of birds and pectoral fins of fish
Homologous organs share a common evolutionary origin and basic structural framework. The wings of birds and the pectoral fins of fish are both modified versions of the vertebrate forelimb. They exhibit similar bone patterns and embryonic development, indicating they evolved from the same ancestral appendage. While one is for flying and the other for swimming, their blueprint provides evidence for ancestry.

103. (2) rRNA
Ribosomal RNA (rRNA) sequences are widely used to study phylogeny and determine the evolutionary relationships between different organisms. Because ribosomes are essential for protein synthesis in all living cells, rRNA genes are highly conserved and change very slowly over time. This makes them excellent molecular clocks for comparing species. By analyzing these sequences, scientists can construct detailed and accurate phylogenetic trees.

104. (2) Reproductive isolation
Reproductive isolation is the most critical factor for speciation, the process by which new

discrete, significant genetic shifts rather than the gradual variations proposed by Darwin. His work was fundamental.

86. (4) 0.48
According to the Hardy-Weinberg principle, the frequency of heterozygotes in a population is calculated using the formula 2pq. Given the allele frequencies p as 0.6 and q as 0.4, the calculation involves multiplying 2 by 0.6 and then by 0.4. The resulting frequency is 0.48. This value represents the proportion of the population carrying both alleles at the locus.

87. (2) Gene flow does not occur between the populations of a species.
A biological species is defined as a group of individuals capable of interbreeding to produce fertile offspring. Members share a common gene pool, and variations naturally occur among them. Crucially, each species is reproductively isolated from others to maintain its unique identity. The claim that gene flow does not occur between populations of the same species is incorrect, as migration occurs.

88. (2) Greater variation in Africa than in Asia
Mitochondrial DNA studies suggest an African origin for modern humans because African populations exhibit much greater genetic variation than populations elsewhere. This high diversity indicates that humans have lived in Africa the longest, allowing more time for mutations to accumulate. Populations in other parts of the world show less variation, consistent with the idea that they were founded by small groups.

89. (2) Oxygen
Alexander Oparin proposed that the primitive Earth had a reducing atmosphere, which was essential for the chemical evolution of life. This atmosphere consisted of gases like methane, ammonia, hydrogen, and water vapor. Crucially, free oxygen was absent during this early stage. The lack of oxygen prevented the oxidation of organic molecules, allowing them to accumulate and eventually combine into living systems.

90. (3) electron spin resonance (ESR) and fossil DNA
Recent advancements in dating techniques have provided more precise timelines for evolutionary history. These include electron spin resonance (ESR), which measures radiation-induced changes in crystals, and the analysis of fossil DNA. These sophisticated methods allow scientists to date older specimens more accurately than traditional radio-carbon dating. Such technologies have led to the revision of various geological periods and evolutionary timelines.

91. (1) due to long periods of evolutionary changes
The diversification of plant life on Earth did not happen overnight; rather, it was the result of long periods of gradual evolutionary changes. Over millions of years, plants adapted to various terrestrial environments, developing complex structures like vascular tissues, seeds, and flowers. These changes were driven by natural selection acting on genetic variations, allowing plants to occupy diverse ecological niches globally.

92. (4) Evidence from DNA extracted from sex chromosomes, autosomes.
Molecular evidence provides strong support for the close relationship between humans and chimpanzees. Analysis of DNA extracted from sex chromosomes and autosomes shows a remarkably high degree of similarity between the two species. This genetic data, combined with morphological and fossil evidence, indicates that humans and chimpanzees shared a common ancestor more recently than with other apes like gorillas or orangutans.

93. (3) Overproduction, constancy of population size, variations, natural selection
Darwin and Wallace proposed a logical sequence for organic evolution based on observations. First, populations tend to overproduce offspring, yet their sizes usually remain constant due to limited resources. This leads to a struggle for existence. Within these populations, variations exist among individuals. Those with favorable variations are more likely to survive and reproduce, a process known as natural selection.

94. (4) dogfish and whale.
Convergent evolution is illustrated by the dogfish, which is a cartilaginous fish, and the whale, which is a mammal. Both have evolved similar streamlined body shapes and fins or flippers to move efficiently in an aquatic environment. Despite their very different evolutionary origins and internal anatomy, these similar traits evolved independently to meet the same functional requirements of swimming.

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these plates. This experiment demonstrated that mutations for resistance occur spontaneously.

114. (3) convergent evolution
When organisms with different genotypes and evolutionary backgrounds develop similar physical traits, it is known as convergent evolution. This happens because these species are subject to similar environmental pressures and ecological demands, leading to the selection of analogous structures. These structures perform similar functions but do not share a recent common ancestor. Examples include the wings of birds and insects.

115. (2) long term evolutionary change
The vast diversity seen in living beings today is the result of long-term evolutionary changes occurring over millions of years. This process involves the gradual accumulation of genetic variations through mutations and recombination, which are then acted upon by natural selection. As populations adapt to different environments and ecological niches, they diverge into new species. This continuous process produced current life complexity.

116. (2) mutation
While some mutations can be beneficial, many are neutral or even harmful. In some cases, mutations can lead to a generation being less adaptive than its parents by disrupting finely tuned genetic sequences that are well-suited to the environment. This decrease in fitness can result from random genetic changes that interfere with normal biological functions. Natural selection usually removes these traits.

117. (1) More diversity in improved variety
The center of origin for a plant species is the geographical region where it first evolved and achieved its greatest natural diversity. In these areas, one often finds the highest variation in improved varieties and wild relatives. This diversity is crucial for plant breeders because it provides a rich source of genetic traits used to develop better and more resilient crops.

118. (1) Chimpanzee
Among all living primates, the chimpanzee is the closest relative to humans. Genetic studies have shown that humans and chimpanzees share approximately 98 to 99 percent of their DNA. This high level of genetic similarity, along with numerous anatomical and behavioral parallels, indicates that the two species shared a common ancestor more recently than they did with any other great ape.

119. (2) Peking man, Heidelberg man, Neanderthal man, Cromagnon man
The evolutionary history of humans involves several intermediate stages. Peking man, an example of Homo erectus, was followed by Heidelberg man. Later, Neanderthal man emerged with complex social behaviors. This was followed by Cro-magnon man, who is considered an early modern Homo sapiens. This sequence traces the progression of hominids through increasing brain size and more sophisticated tool use over time.

120. (2) Nails
Vestigial organs are remnants of structures that were functional in an ancestor but have lost their original purpose. In humans, examples include the third molar, the coccyx, and the segmental muscles of the abdomen. However, nails are not vestigial organs. They serve important functions like protecting the tips of the fingers and assisting in grasping, making them functional structures in humans.

121. (1) Evidences from biogeographical distribution
Darwin finches provide compelling evidence for evolution through their biogeographical distribution on the Galapagos Islands. Darwin noticed that while these birds were similar to species on the mainland of South America, they had diversified into many distinct forms on different islands. Their unique beak shapes were adapted to specific food sources. This observation supported the idea that species change over time as they adapt.

122. (1) Replication of genetic material
From an evolutionary perspective, the replication of genetic material is the most important factor for the continuity of a species. DNA carries the hereditary information required for the functioning of all living organisms. By accurately copying this information and passing it to offspring, a species ensures that its essential traits are preserved across generations. This process allows for both stability and variations.

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2023

21. In which blood corpuscles, the HIV undergoes replication and produces progeny viruses?
(1) Basophils
(2) Eosinophils
(3) T_H cells
(4) B-lymphocytes

Manipur NEET 2023

22. Diacetyl morphine is also called as
(1) amphetamine
(2) barbiturate
(3) crack
(4) smack.

2023

23. Match List I with List II.

	List-I		List-II
A.	Heroin	I.	Effect on cardiovascular system
B.	Marijuana	II.	Slow down body function
C.	Cocaine	III.	Painkiller
D.	Morphine	IV.	Interfere with transport of dopamine

Choose the correct answer from the options given below.
(1) A-IV, B-III, C-II, D-I
(2) A-III, B-IV, C-I, D-II
(3) A-II, B-I, C-IV, D-III
(4) A-I, B-II, C-III, D-IV

2022

24. Given below are two statements:
Statement I : Autoimmune disorder is a condition where body defense mechanism recognizes its own cells as foreign bodies.
Statement II : Rheumatoid arthritis is a condition where body does not attack self cells.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Both Statement I and Statement II are correct
(2) Both Statement I and Statement II are incorrect
(3) Statement I is correct but Statement II is incorrect
(4) Statement I is incorrect but Statement II is correct

2022

25. Select the incorrect statement with respect to acquired immunity.
(1) Primary response is produced when our body encounters a pathogen for the first time.
(2) Anamnestic response is elicited on subsequent encounters with the same pathogen.
(3) Anamnestic response is due to memory of first encounter.
(4) Acquired immunity is non-specific type of defense present at the time of birth.

2021

26. Match List-I with List-II.

	List-I		List-II
(p)	Filariasis	(i)	Haemophilus influenzae
(q)	Amoebiasis	(ii)	Trichophyton
(r)	Pneumonia	(iii)	Wuchereria bancrofti
(s)	Ringworm	(iv)	Entamoeba histolytica

Choose the correct answer from the options given below
(1) (p)-(ii); (q)-(iii); (r)-(i); (s)-(iv)
(2) (p)-(iv); (q)-(i); (r)-(iii); (s)-(ii)
(3) (p)-(iii); (q)-(iv); (r)-(i); (s)-(ii)
(4) (p)-(i); (q)-(ii); (r)-(iv); (s)-(iii)

2020

27. The infectious stage of Plasmodium that enters the human body is
(1) Trophozoites
(2) Sporozoites
(3) Female gametocytes
(4) Male gametocytes

2020

28. Match the following diseases with the causative organism and select the correct option.

	Column I		Column II
A.	Typhoid	(i)	Wuchereria
B.	Pneumonia	(ii)	Plasmodium
C.	Filariasis	(iii)	Salmonella
D.	Malaria	(iv)	Haemophilus

(1) A-(i); B-(iii); C-(ii); D-(iv)
(2) A-(iii); B-(iv); C-(i); D-(ii)
(3) A-(ii); B-(i); C-(iii); D-(iv)
(4) A-(iv); B-(i); C-(ii); D-(iii)

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substantial shifts in the gene pool. In large populations, these fluctuations are balanced.

133. (4) 25 x 10^6 years back.
Dryopithecus was a genus of primates that lived approximately 15 million years ago during the Miocene epoch. Fossils of this group have been found in various parts of Africa, Europe, and Asia. Dryopithecus is considered an important ancestor in the evolutionary lineage of both modern apes and humans. These primates were hairy and walked like gorillas and chimpanzees.

134. (2) development of a common set of characteristics in groups of different ancestry
Evolutionary convergence is characterized by the development of a common set of characteristics in groups of different ancestry. This occurs when unrelated species face similar environmental challenges or ecological pressures, leading them to independently evolve analogous structures. These structures perform similar functions but do not share a recent common origin. Examples include wings of insects and birds or bodies of marine mammals.

135. (1) Homo erectus is preceded by Homo habilis.
In the chronological sequence of human evolution, Homo erectus is preceded by Homo habilis. Homo habilis lived between 2.4 and 1.4 million years ago and was known for using simple stone tools. Homo erectus appeared later, around 1.9 million years ago, and exhibited a larger brain and more advanced technology. This progression shows increasing physical and mental complexity within the genus Homo.

136. (2) chromosome number
The close evolutionary relationship between humans and chimpanzees is best demonstrated by their highly similar chromosome numbers and structures. Humans have 46 chromosomes, while chimpanzees have 48. Detailed analysis shows that human chromosome 2 was formed by the fusion of two ancestral chromosomes still found in chimpanzees. This chromosomal evidence strongly supports the conclusion that humans and chimpanzees share a common ancestor.

137. (4) NH_3, water, nucleic acid and protein.
The manufacture of organic compounds on the primitive Earth followed a logical progression from simple to complex molecules. First, inorganic gases like ammonia and water vapor were present in the atmosphere. These then combined to form simple organic molecules, which eventually organized into proteins. Finally, the synthesis of nucleic acids occurred, providing the genetic blueprint necessary for life and early biological evolution.

138. (4) Wisdom tooth, body hairs, nictitating membrane and vermiform appendix
Vestigial organs are non-functional remnants of structures that were functional in ancestors. In humans, a well-known group of these includes the wisdom tooth, body hair, the nictitating membrane of the eye, and the vermiform appendix. These structures have lost their original biological importance over millions of years. Their continued presence in the human body serves as significant evidence for our evolutionary past.

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139. (3) Loss of tail
During the course of human evolution, several physical changes occurred as ancestors adapted to an upright, bipedal lifestyle. While developments like being erect and increasing cranial capacity were clearly advantageous, the loss of the tail was probably a useless change in terms of direct survival benefit. In many other primates, the tail serves for balance, but it became redundant for ground-dwelling ancestors.

140. (4) Homo sapiens fossilis
In the lineage of human evolution, Homo sapiens fossilis, which includes groups like Cro-magnon man, is considered the direct ancestor of modern Homo sapiens. These early modern humans possessed physical features, brain capacities, and cultural practices very similar to our own. They lived during the late Pleistocene and were skilled toolmakers. This connection represents the final stage in human evolutionary progression.

141. (3) dog
The dog was the first animal to be domesticated by primitive humans, likely occurring between 15,000 and 30,000 years ago. This domestication probably began when wolves started scavenging around human camps and gradually developed a symbiotic relationship. Dogs provided early humans with assistance in hunting, protection, and companionship. This milestone marked the beginning of human-animal cooperation and paved the way for later domestication.

123. (4) Holocene.
Modern humans, Homo sapiens, have continued to evolve and flourish during the Holocene epoch. This period began approximately 11,700 years ago, following the last major ice age, and continues to the present day. During the Holocene, humans transitioned to sedentary agriculture and complex civilizations. While the genus Homo originated earlier, the recent history of modern humans is defined by Holocene events.

124. (2) reduction in size of jaws
A prominent character closely associated with human evolution is the progressive reduction in the size of the jaws. As ancestral hominids shifted their diets toward softer, cooked foods and began using tools, the need for large, powerful jaws diminished. This change led to a more refined facial structure and also provided more space for the expansion of the brain over time.

125. (1) Gorilla
Among the primates listed, the gorilla is one of the most directly related to humans. Along with chimpanzees and orangutans, gorillas belong to the family Hominidae, known as the great apes. While chimpanzees are our closest living relatives, gorillas also share a very high degree of genetic and anatomical similarity with humans, reflecting a common ancestry that diverged recently in Africa.

126. (3) natural selection
Industrial melanism is a classic demonstration of natural selection in response to environmental change. In areas of England affected by industrial pollution, the frequency of dark-colored peppered moths increased significantly. This occurred because the dark moths were better camouflaged against soot-covered trees, protecting them from avian predators. This case clearly shows how nature selects for individuals with traits that offer survival.

127. (1) Wings of bird and hands of human
Homologous organs are structures that share a common evolutionary origin and basic anatomical plan. The wings of a bird and the hands of a human are both modified versions of the ancestral vertebrate forelimb. They contain the same basic arrangement of bones, including the humerus, radius, and ulna. Despite being used for very different functions, their shared blueprint provides evidence for ancestry.

128. (3) Homo erectus is the ancestor of man.
Homo erectus is a key direct ancestor in the evolutionary lineage of modern humans. This species appeared about two million years ago and was the first to exhibit a truly upright posture and body proportions similar to modern humans. They also had a significantly larger brain than earlier hominids and were known for their advanced stone tools and use of fire.

129. (3) origin of species by natural selection
The diversity of beak shapes among the finches of the Galapagos Islands provides powerful evidence for the origin of species by natural selection. Darwin observed that these birds had adapted their beaks to efficiently exploit different food sources. Those individuals with beak traits best suited to the available food were more likely to survive and reproduce, leading to the diversification of species.

130. (2) allopatric
Species that occur in different, non-overlapping geographical areas are referred to as allopatric. This spatial separation often leads to allopatric speciation, where physical barriers like mountains or oceans prevent gene flow between populations. Over time, these isolated groups accumulate genetic differences through mutation and selection. If the differences become large enough to prevent interbreeding, they are considered distinct biological species.

131. (3) Biogenetic law
The observation that the mammalian heart passes through stages resembling those of fish and amphibians during its development aligns with the Biogenetic Law. This principle suggests that an organism embryonic development mirrors the evolutionary history of its ancestors. While modern biology has refined this view, the presence of these transitional embryonic forms remains a significant piece of evidence for the shared evolutionary path.

132. (4) smaller populations.
Genetic drift is an evolutionary mechanism involving random changes in allele frequencies due to chance events. While it occurs in all populations, its impact is most significant and noticeable in smaller populations. In these groups, the accidental death or reproductive failure of even a few individuals can lead to

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environments. These similar traits, known as analogous structures, perform similar functions but do not share a recent common origin. Examples include the wings of birds and insects or the bodies of sharks.

152. (2) natural selection acting on favourable variations
Charles Darwin Theory of Natural Selection dwells on the principle that nature selects for individuals with favorable variations. In any population, individuals with traits that are better suited to their environment are more likely to survive and reproduce. These advantageous variations are then passed on to the next generation. Over time, this process leads to the gradual adaptation and evolution of a species.

153. (4) Lamarckism was wrong in inheritance of acquired characters.
August Weismann experiment of cutting off the tails of mice for many generations provided strong evidence against Lamarckism. He observed that despite the loss of their tails, the offspring were always born with normal tails. This showed that changes acquired by the body during an organism life are not inherited. His work established the theory of the continuity of germplasm in genetics.

154. (3) gene frequency from one generation to next
Genetic drift is defined as the change in gene frequency from one generation to the next due to random chance events. Unlike natural selection, which is driven by the fitness of individuals, genetic drift is a stochastic process that can cause certain alleles to become more common purely by accident. This process is particularly influential in small populations, altering the gene pool.

155. (2) chemoheterotrophs
The first living organisms on Earth are widely believed to have been chemoheterotrophs. These primitive, unicellular life forms emerged in the early oceans and obtained their energy by consuming organic molecules that had formed through chemical evolution. Since the early atmosphere lacked free oxygen, these organisms were also anaerobic. They represent the simplest stage of biological existence, eventually giving rise to autotrophs.

156. (3) O_2
At the time of the origin of life on Earth, the atmosphere was a reducing one, containing gases such as methane, ammonia, and hydrogen. Crucially, free oxygen was absent from this primitive environment. The lack of oxygen was essential for chemical evolution, as it allowed organic molecules to accumulate without being oxidized. Later, with the evolution of photosynthetic organisms, oxygen began to build.

157. (1) palaeontology
Palaeontology is the scientific study of fossils to understand the history of life on Earth. By examining the remains or traces of ancient organisms preserved in rock layers, palaeontologists can reconstruct past environments and trace the evolutionary lineages of different species. This field provides direct evidence for the changes that have occurred in living things over millions of years of history.

158. (3) Palaeozoic → Mesozoic → Cenozoic
The correct chronological order of major geological eras, from oldest to most recent, is Palaeozoic, Mesozoic, and Cenozoic. The Palaeozoic era saw the rise of fish and early land plants. The Mesozoic era followed, famously known as the age of dinosaurs and reptiles. Finally, the Cenozoic era represents the current era, characterized by the radiation of mammals and modern global ecosystems.

159. (4) adaptive convergence of closely related groups.
Parallelism, or parallel evolution, occurs when closely related groups independently develop similar adaptations after their lineages have diverged. This often happens because these related species occupy similar environments and face comparable selection pressures. Unlike convergent evolution, which involves distantly related species, parallelism involves groups with a recent common ancestor that follow similar evolutionary paths, demonstrating how similar backgrounds lead to identical traits.

160. (1) Von Baer
The basic principles of embryonic development were famously pronounced by Karl Ernst von Baer. He observed that embryos of different species tend to resemble each other more in their early stages and become increasingly distinct as

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2025

8. Which of the following type of immunity is present at the time of birth and is a non-specific type of defence in the human body?
(1) Cell-mediated Immunity
(2) Humoral Immunity
(3) Acquired Immunity
(4) Innate Immunity

2025

9. Identify the statement that is not correct.
(1) Antigen binding site is located at C-terminal region of antibody molecules.
(2) Constant region of heavy and light chains are located at C-terminus of antibody molecules.
(3) Each antibody has two light and two heavy chains.
(4) The heavy and light chains are held together by disulfide bonds.

2025

10. Neoplastic characteristics of cells refer to:
A. A mass of proliferating cell
B. Rapid growth of cells
C. Invasion and damage to the surrounding tissue
D. Those confined to original location
Choose the correct answer from the options given below
(1) A, B, D only
(2) B, C, D only
(3) A, B only
(4) A, B, C only

2025

11. Which are correct?
A. Computed tomography and magnetic resonance imaging detect cancers of internal organs.
B. Chemotherapeutics drugs are used to kill non-cancerous cells.
C. a-interferon activate the cancer patients' immune system and helps in destroying the tumour.
D. Chemotherapeutic drugs are biological response modifiers.
E. In the case of leukaemia blood cell counts are decreased.
Choose the correct answer from the options given below.
(1) C and D only
(2) A and C only
(3) B and D only
(4) D and E only

2024

12. Match List I with List II :

	List-I		List-II
A.	Typhoid	I.	Fungus
B.	Leishmaniasis	II.	Nematode
C.	Ringworm	III.	Protozoa
D.	Filariasis	IV.	Bacteria

Choose the correct answer from the options given below.
(1) A-I, B-III, C-II, D-IV
(2) A-IV, B-III, C-I, D-II
(3) A-III, B-I, C-IV, D-II
(4) A-II, B-IV, C-III, D-I

RE-EXAM 2024

13. Match List-I with List-II.

	List-I		List-II
A.	B-Lymphocytes	I.	Passive immunity
B.	Interferons	II.	Cell mediated immunity
C.	T-lymphocytes	III.	Produce an army of proteins in response to pathogens
D.	Colostrum	IV.	Innate immunity

Choose the correct answer from the options given below.
(1) A-I, B-IV, C-II, D-III
(2) A-IV, B-II, C-III, D-I
(3) A-III, B-IV, C-II, D-I
(4) A-II, B-IV, C-I, D-III

2024

14. Match List-I with List-II :

	List-I		List-II
A.	Common cold	I.	Plasmodium
B.	Haemozoin	II.	Typhoid
C.	Widal test	III.	Rhinoviruses
D.	Allergy	IV.	Dust mites

Choose the correct answer from the options given below :
(1) A-II, B-IV, C-III, D-I
(2) A-I, B-III, C-II, D-IV
(3) A-III, B-I, C-II, D-IV
(4) A-IV, B-II, C-III, D-I

NODIA

CHAPTER 26
Human Health and Diseases

2026 (RE-NEET)

1. Which is used as an effective sedative and painkiller for treating post-surgery patients?
(1) Morphine
(2) Anti-retroviral drugs
(3) Interferon
(4) Antibiotics

2026 (RE-NEET)

2. Colostrum, secreted by mother during initial days of lactation, is abundant in ___.
(1) IgA
(2) IgD
(3) IgG
(4) IgM

2026 (RE-NEET)

3. Which of the following statements is correct about Plasmodium ?
(1) Gametocytes develop in mosquito gut
(2) Fertilization takes place in mosquito gut
(3) Reproduces sexually in liver cells
(4) Reproduces sexually in RBCs

2026 (RE-NEET)

4. Which of the following are secondary lymphoid organs? (a) Bone marrow, (b) Tonsils, (c) Spleen, (d) Thymus.
(1) (b) and (d) only
(2) (a) and (d) only
(3) (a) and (b) only
(4) (b) and (c) only

2026 (CANCELLED)

5. The following are the stages in the life cycle of Plasmodium. Arrange the stages in the proper order:
A. The parasites reproduce asexually in RBCs, bursting the cells.
B. The parasites reproduce asexually in liver cells, bursting the cells and releasing into blood.
C. Gametocytes develop in RBCs.
D. Sporozoites reach the liver through the blood.
E. Female mosquito injects sporozoites into humans during bite.
Choose the correct answer from the options given below:
(1) E, D, B, A, C
(2) A, B, C, D, E
(3) C, A, B, D, E
(4) E, C, D, B, A

2026 (CANCELLED)

6. Match List I with List II:
List I (Drug):
A. Nicotine
B. Morphine
C. Heroin
D. Cocaine
List II (Effect):
I. Causes sense of euphoria and increased energy
II. Stimulates adrenal gland to release catecholamines into blood circulation
III. Effective sedative and painkiller
IV. A depressant; slows down body function
Choose the correct answer from the options given below:
(1) A-III, B-II, C-IV, D-I
(2) A-II, B-III, C-I, D-IV
(3) A-II, B-III, C-IV, D-I
(4) A-III, B-II, C-I, D-IV

2025

7. After maturation, in primary lymphoid organs, the lymphocytes migrate for interaction with antigens to secondary lymphoid organ(s)/ tissue(s) like
A. thymus
B. bone marrow
C. spleen
D. lymph nodes
E. Peyer's patches
Choose the correct answer from the options given below:
(1) E, A, B only
(2) C, D, E only
(3) B, C, D only
(4) A, B, C only

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142. (2) Strontium-90
Strontium-90 is considered one of the most dangerous isotopes for Homo sapiens. Because it is chemically similar to calcium, the body easily absorbs it and incorporates it into bone tissue and teeth. Once there, it can remain for many years, emitting radiation that can cause bone cancer. Strontium-90 is a major product of nuclear fission and can enter the food chain easily.

143. (1) mutation
The change of the peppered moth from its light-colored variety to its darker form is primarily due to a genetic mutation. This mutation produced a dark phenotype that had a significant survival advantage in industrial areas where tree trunks were blackened by soot. While natural selection then acted to increase the frequency, the original source of variation was a random mutation in DNA.

144. (3) origin
Homologous organs are structures in different species that are similar because they share a common evolutionary origin and basic anatomical plan. While these organs may look different and perform vastly different functions, their underlying structural framework is the same. This similarity in origin provides strong evidence for common ancestry and divergent evolution, where a single ancestral structure was modified to suit various environments.

145. (4) recapitulation.
The presence of gill slits in the embryos of all vertebrates, including mammals and birds, provides strong support for the theory of recapitulation. This theory suggests that the embryonic development of an organism repeats or reflects the adult stages of its evolutionary ancestors. While fish use gill slits for breathing, in other vertebrates, these structures disappear or are modified during their development.

146. (1) Precambrian
The Precambrian is dubbed as the age of prokaryotic microbes because it encompasses the vast period of Earth history when life was almost exclusively unicellular and microscopic. During this time, the first prokaryotes appeared and diversified, including anaerobic bacteria and later, oxygen-producing cyanobacteria. These simple organisms dominated the planet for billions of years before the emergence of more complex multicellular life forms.

147. (3) Eohippus
The earliest known fossil form in the evolutionary lineage of the horse is Eohippus, also known as Hyracotherium. Living approximately 50 million years ago during the Eocene epoch, Eohippus was a small, dog-sized animal with four toes on its front feet and three on its hind feet. It lived in forest environments and browsed on soft leaves, marking the horse start.

148. (1) Pectoral fin of rohu and forelimb of horse
The pectoral fin of a rohu fish and the forelimb of a horse are considered a pair of homologous organs. Despite their different functions, both structures share a common evolutionary origin as part of the vertebrate skeletal system. They exhibit a similar basic anatomical plan and develop from the same embryonic tissues. This homology indicates that fish and mammals share a distant common ancestor.

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149. (2) Melanisation in peppered moth
Lamarck theory of inheritance of acquired characters suggests that traits developed by an organism during its lifetime can be passed to its offspring. Phenomena like the loss of pigment in cave animals are often cited. However, the melanisation of the peppered moth does not support Lamarckism. Instead, it is a clear example of natural selection acting on pre-existing genetic variations in the population.

150. (2) Change of diet from hard nuts and hard roots to soft food
During human evolution, many physical and behavioral changes occurred, such as the perfection of the hand for tool use and the development of complex communication. However, a significant change in diet from hard nuts and roots to soft food is relatively irrelevant to the core process of biological evolution compared to others. While dietary shifts occurred, they were largely a consequence of cultural developments.

151. (1) common set of characters in group of different ancestry
Evolutionary convergence is the process where organisms from different ancestral backgrounds develop a common set of characters. This occurs when unrelated species independently evolve similar adaptations to thrive in comparable

2024

15. Given below are two statements.

Statement I : Bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced.

Statement II : Both bone marrow and thymus provide micro environments for the development and maturation of T-lymphocytes.

In the light of the above statements, choose the most appropriate answer from the options given below.

(1) Both Statement I and Statement II are correct.
(2) Both Statement I and Statement II are incorrect.
(3) Statement I is correct but Statement II is incorrect.
(4) Statement I is incorrect but Statement II is correct.

RE-EXAM 2024

16. Match List-I with List-II.

	List-I		List-II
A.	Malignant tumors	I.	Destroy tumors
B.	MALT	II.	AIDS
C.	NACO	III.	Metastasis
D.	a-interferons	IV.	Lymphoid tissue

Choose the correct answer from the options given below.

(1) A-III, B-IV, C-II, D-I
(2) A-IV, B-III, C-II, D-I
(3) A-III, B-IV, C-I, D-II
(4) A-III, B-I, C-IV, D-II

2024

17. Match List I with List II :

	List-I		List-II
A.	Cocaine	I.	Effective sedative in surgery
B.	Heroin	II.	Cannabis sativa
C.	Morphine	III.	Erythroxylum
D.	Marijuana	IV.	Papaver somniferum

Choose the correct answer from the options given below.

(1) A-IV, B-III, C-I, D-II
(2) A-I, B-III, C-II, D-IV
(3) A-II, B-I, C-III, D-IV
(4) A-III, B-IV, C-I, D-II

Manipur NEET 2023

18. Match List I with List II.

	List-I		List-II
A.	Typhoid	I.	Protozoan
B.	Elephantiasis	II.	Salmonella
C.	Ringworm	III.	Aschelminthes
D.	Malaria	IV.	Microsporum

Choose the correct answer from the options given below.

(1) (A)-(I), (B)-(IV), (C)-(III), (D)-(II)
(2) (A)-(I), (B)-(III), (C)-(IV), (D)-(II)
(3) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
(4) (A)-(II), (B)-(IV), (C)-(III), (D)-(I)

2023

19. Match List I with List II.

	List-I		List-II
A.	Ringworm	I.	Haemophilus influenzae
B.	Filariasis	II.	Trichophyton
C.	Malaria	III.	Wuchereria bancrofti
D.	Pneumonia	IV.	Plasmodium vivax

Choose the correct answer from the options given below.

(1) A-III, B-II, C-I, D-IV
(2) A-III, B-II, C-IV, D-I
(3) A-II, B-III, C-IV, D-I
(4) A-II, B-III, C-I, D-IV

Manipur NEET 2023

20. Match List I with List II.

	List-I		List-II
A.	Cytokine barriers	I.	Mucus coating of respiratory tract
B.	Cellular barriers	II.	Interferons
C.	Physiological barriers	III.	Neutrophils and macrophages
D.	Physical barriers	IV.	Tears and saliva

Choose the correct answer from the options given below :

(1) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
(2) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(3) (A)-(III), (B)-(I), (C)-(II), (D)-(IV)
(4) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)

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they grow. Von Baer work laid the foundation for modern embryology by showing that general features appear before specialized ones, providing an accurate understanding of development.

161. (2) history and development of race along with variations
Evolution is defined as the history and development of a biological race over time, accompanied by the accumulation of genetic variations. It is a continuous process of change through which modern organisms have descended from ancestral forms. This transformation is driven by mechanisms such as mutation, natural selection, and genetic drift. By studying evolution, we can understand how various diverse species adapt.

162. (2) Weismann
The Continuity of Germplasm theory was proposed by August Weismann in the late 19th century. He argued that hereditary information is exclusively carried by germ cells, such as eggs and sperm, rather than somatic cells. According to this theory, changes acquired by an organism body during its lifetime cannot be passed to its offspring. This idea was crucial in refuting Lamarckism.

163. (2) Lamarck
Jean-Baptiste Lamarck proposed the first comprehensive theory of evolution, centered on the idea of the inheritance of acquired characters. He believed that organisms could develop new traits during their lifetimes through the use or disuse of certain organs and that these changes could then be passed on to their offspring. Although this mechanism was later disproved, Lamarck work was pioneering in biology.

164. (4) Darwin.
The seminal book On the Origin of Species by Means of Natural Selection was written by Charles Darwin and published in 1859. In this work, Darwin presented a wealth of evidence for the theory of evolution and introduced the mechanism of natural selection. His ideas revolutionized biology by providing a scientific framework for understanding the common ancestry and diversification of life globally.

165. (3) adaptive radiation
Humming birds and hawks illustrate the concept of adaptive radiation within the bird lineage. Starting from a common ancestral bird, these groups diversified to fill vastly different ecological niches. Humming birds evolved specialized beaks for feeding on nectar, while hawks developed sharp talons for predatory hunting. This diversification shows how natural selection can lead to specialized forms from a single common origin.

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166. (3) Analogy, Convergent
Sweet potato and potato provide a classic example of analogous organs resulting from convergent evolution. A sweet potato is a modified root, while a common potato is a modified stem. Although they have completely different anatomical origins, both have evolved to perform the same function of storing food underground. This functional similarity developed independently in different plant lineages to adapt properly.

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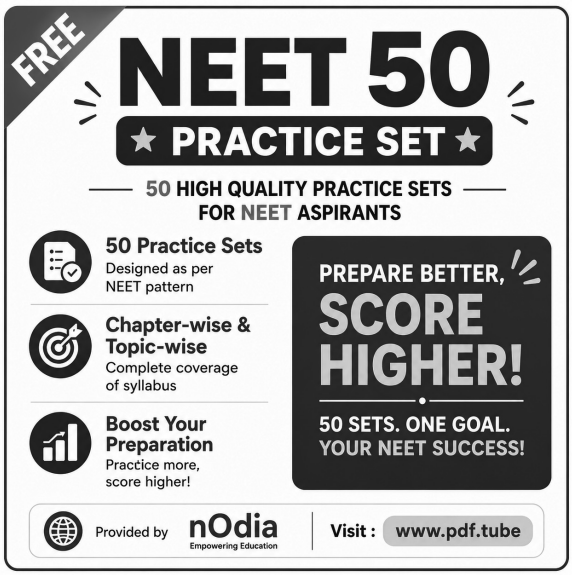

2020

29. Identify the wrong statement with reference to immunity.
(1) When exposed to antigen (living or dead) antibodies are produced in the host's body. It is called "Active immunity".
(2) When ready-made antibodies are directly given, it is called "Passive immunity".
(3) Active immunity is quick and gives full response.
(4) Fetus receives some antibodies from mother, it is an example for passive immunity.

2019

30. Identify the correct pair representing the causative agent of typhoid fever and the confirmatory test for typhoid.
(1) Salmonella typhi / Widal test
(2) Plasmodium vivax / UTI test
(3) Streptococcus pneumoniae / Widal test
(4) Salmonella typhi / Anthrone test

2019

31. Which of the following immune responses is responsible for rejection of kidney graft?
(1) Cell-mediated immune response
(2) Auto-immune response
(3) Humoral immune response
(4) Inflammatory immune response

2019

32. Colostrum, the yellowish fluid, secreted by mother during the initial days of lactation is very essential to impart immunity to the new born infants because it contains
(1) immunoglobulin A
(2) natural killer cells
(3) monocytes
(4) macrophages.

2019

33. Drug called 'Heroin' is synthesised by
(1) nitration of morphine
(2) methylation of morphine
(3) acetylation of morphine
(4) glycosylation of morphine.

2018

34. In which disease does mosquito transmitted pathogen cause chronic inflammation of lymphatic vessels?
(1) Elephantiasis
(2) Ascariasis
(3) Ringworm disease
(4) Amoebiasis

2018

35. Which of the following is not an autoimmune disease?
(1) Psoriasis
(2) Rheumatoid arthritis
(3) Alzheimer's disease
(4) Vitiligo

2018

36. Which part of poppy plant is used to obtain the drug "smack"?
(1) Flowers
(2) Latex
(3) Roots
(4) Leaves

2017

37. Transplantation of tissues/organs fails often due to non-acceptance by the patient's body. Which type of immune response is responsible for such rejections?
(1) Cell-mediated immune response
(2) Hormonal immune response
(3) Physiological immune response
(4) Autoimmune response

2017

38. MALT constitutes about ___ percent of the lymphoid tissue in human body.
(1) 20% (2) 70%
(3) 10% (4) 50%

NEET-II 2016

39. Which of the following sets of diseases is caused by bacteria?
(1) Cholera and tetanus
(2) Typhoid and smallpox
(3) Tetanus and mumps
(4) Herpes and influenza

NEET-I 2016

40. Antivenom injection contains preformed antibodies while polio drops that are administered into the body contain
(1) gamma globulin
(2) attenuated pathogens
(3) activated pathogens
(4) harvested antibodies.

NEET-I 2016

41. In higher vertebrates, the immune system can distinguish self-cells and non-self. If this property is lost due to genetic abnormality and it attacks self-cells, then it leads to
(1) autoimmune disease
(2) active immunity

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modifiers like alpha-interferon are administered to cancer patients to activate their immune system for tumor destruction. In contrast, chemotherapeutic drugs target rapidly dividing cells, including non-cancerous ones, and leukemia is characterized by an abnormal increase in white blood cells.

12. (2) A-IV, B-III, C-I, D-II
Typhoid is a bacterial disease caused by Salmonella typhi, while leishmaniasis is triggered by protozoans like Leishmania donovani. Ringworm is a common fungal infection affecting the skin, and filariasis is caused by nematode worms such as Wuchereria bancrofti. Each of these diseases represents a different class of pathogenic organisms requiring specific diagnostic and treatment approaches within medical science.

13. (3) A-III, B-IV, C-II, D-I
B-lymphocytes produce an army of proteins called antibodies in response to pathogens, whereas T-lymphocytes are central to cell-mediated immunity. Interferons are part of the innate immune system, specifically acting as cytokine barriers against viral infections. Colostrum provides passive immunity to newborns by supplying preformed antibodies like IgA. These components work together to provide comprehensive defense against various diseases.

14. (3) A-III, B-I, C-II, D-IV
Rhinoviruses are the primary causative agents of the common cold in humans. In malaria, the rupture of red blood cells releases haemozoin, which causes recurring chills and fever. The Widal test is a specific serological diagnosis for typhoid fever. Allergies are often triggered by environmental factors such as dust mites, which cause hypersensitive reactions in susceptible individuals.

15. (1) Both Statement I and Statement II are correct.
Bone marrow serves as the primary lymphoid organ where all blood cells, including B and T lymphocytes, are generated. Both the bone marrow and the thymus provide the specialized microenvironments necessary for the development, maturation, and selection of T-lymphocytes. These organs ensure that lymphocytes become immunocompetent before they migrate to secondary lymphoid tissues to encounter various foreign antigens.

16. (1) A-III, B-IV, C-II, D-I
Malignant tumors are characterized by metastasis, where cancerous cells spread to distant sites. Mucosa-associated lymphoid tissue represents a significant portion of the body's lymphoid tissue. The National AIDS Control Organisation is a specialized agency dealing with HIV prevention and awareness. Alpha-interferons serve as biological response modifiers that help activate the immune system to recognize and destroy tumor cells.

17. (4) A-III, B-IV, C-I, D-II
Cocaine is an alkaloid derived from the Erythroxylum coca plant, while heroin is synthesized from the latex of Papaver somniferum. Morphine acts as a potent sedative and painkiller, making it highly effective during surgical procedures. Marijuana is obtained from the inflorescences of the Cannabis sativa plant. These substances vary significantly in their physiological effects and medical applications.

18. (3) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
Typhoid is caused by the bacterium Salmonella typhi, while elephantiasis is a chronic infection caused by Aschelminthes like Wuchereria. Ringworm is a fungal infection often caused by organisms in the genus Microsporum. Malaria is a widespread disease caused by protozoan parasites of the genus Plasmodium. Understanding these causative agents is essential for the effective prevention and treatment of infections.

19. (3) A-II, B-III, C-IV, D-I
Ringworm is a fungal skin infection caused by genera like Trichophyton. Filariasis is a parasitic disease caused by the filarial worm Wuchereria bancrofti. Malaria is caused by protozoan parasites such as Plasmodium vivax, which are transmitted via mosquito bites. Pneumonia is an inflammatory condition of the lungs typically caused by bacteria like Haemophilus influenzae or Streptococcus pneumoniae in humans.

20. (1) (A)-(II), (B)-(III), (C)-(IV), (D)-(I)
Cytokine barriers include proteins like interferons that protect non-infected cells from viral spread. Cellular barriers consist of specialized white blood cells like neutrophils and macrophages. Physiological barriers involve secretions such as

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(1) Hallucinogen
(2) Depressant
(3) Stimulant
(4) Pain killer

2013

53. Infection of Ascaris usually occurs by
(1) Tse-tse fly
(2) mosquito bite
(3) drinking water containing eggs of Ascaris
(4) eating imperfectly cooked pork.

Karnataka NEET 2013

54. Identify the site where Wuchereria bancrofti is normally found in human body.
(1) Muscles of the legs
(2) Blood vessels of the thigh region
(3) Skin between the fingers
(4) Lymphatic vessels of the lower limbs

Karnataka NEET 2013

55. Which one of the following is a hallucinogenic drug?
(1) Caffeine
(2) Morphine
(3) Lysergic acid diethylamide
(4) Opium

2012

56. Motile zygote of Plasmodium occurs in
(1) gut of female Anopheles
(2) salivary glands of Anopheles
(3) human RBCs
(4) human liver.

2012

57. Widal test is carried out to test
(1) malaria
(2) diabetes mellitus
(3) HIV/AIDS
(4) typhoid fever.

2012

58. Common cold differs from pneumonia in that
(1) pneumonia is a communicable disease whereas the common cold is a nutritional deficiency disease
(2) pneumonia can be prevented by a live attenuated bacterial vaccine whereas the common cold has no effective vaccine
(3) pneumonia is caused by a virus while the common cold is caused by the bacterium Haemophilus influenzae
(4) pneumonia pathogen infects alveoli whereas the common cold affects nose and respiratory passage but not the lungs.

2012

59. Which one of the following is not a property of cancerous cells, whereas the remaining three are?
(1) They compete with normal cells for vital nutrients.
(2) They do not remain confined in the area of formation.
(3) They divide in an uncontrolled manner.
(4) They show contact inhibition.

2012

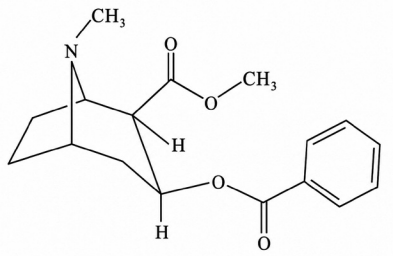
60. Cirrhosis of liver is caused by the chronic intake of
(1) opium (2) alcohol
(3) tobacco (chewing) (4) cocaine.

Mains 2012

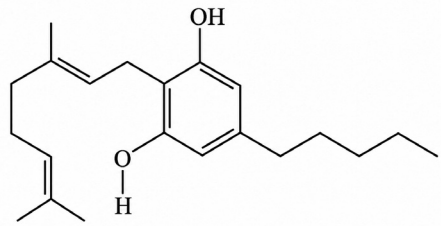
61. Identify the molecules (A) and (B) shown below and select the right option giving their source and use.

NODIA

(A)



(B)



	Molecule	Source	Use
(1)	(A) Cocaine	Erythroxylum coca	Accelerates the transport of dopamine
(2)	(B) Heroin	Cannabis sativa	Depressant and slows down body functions
(3)	(B) Cannabinoid	Atropa belladonna	Produces hallucinations
(4)	(A) Morphine	Papaver somniferum	Sedative and pain killer

2011

62. Where will you look for the sporozoites of the malarial parasite?
(1) Saliva of infected female Anopheles mosquito
(2) Red blood corpuscles of human suffering from malaria

(2) circulatory system
(3) immune system
(4) epithelial cells.

1993

116. Schizont stage of Plasmodium occurs in human
(1) erythrocytes
(2) liver cells
(3) erythrocytes and liver cells
(4) erythrocytes, liver cells and spleen cells.

1993

117. If all ponds and puddles are destroyed, the organism likely to be destroyed is
(1) Leishmania
(2) Trypanosoma
(3) Ascaris
(4) Plasmodium.

1993

118. Give the correct matching of causative agent/ germ and disease.
(1) Anopheles - Malaria
(2) Leishmania - Sleeping sickness
(3) Glossina - Kala-azar
(4) Wuchereria - Filariasis

1993

119. Opiate narcotic is
(1) bhang
(2) charas
(3) heroin
(4) nicotine.

1992

120. The part of life cycle of malarial parasite Plasmodium vivax, that is passed in female Anopheles is
(1) sexual cycle
(2) pre-erythrocytic schizogony
(3) exoerythrocytic schizogony
(4) post-erythrocytic schizogony.

1991

121. African sleeping sickness is due to
(1) Plasmodium vivax transmitted by tse-tse fly
(2) Trypanosoma lewsii transmitted by bed bug
(3) Trypanosoma gambiense transmitted by Glossina palpalis
(4) Entamoeba gingivalis spread by housefly.

1991

122. Malignant tertian malarial parasite, belongs to class
(1) Plasmodium falciparum
(2) P. vivax
(3) P. ovale
(4) P. malariae.

1991

123. Who discovered Plasmodium in RBC of human beings?
(1) Ronald Ross
(2) Mendel
(3) Laveran
(4) Stephens

1990

124. The infective stage of malarial parasite, Plasmodium that enters human body is
(1) merozoite
(2) sporozoite
(3) trophozoite
(4) minuta form.

1990

125. Analgesic drugs
(1) form tissues
(2) relieve pain
(3) relieve fatigue
(4) cause pain.

1989

126. A bite of tse-tse fly may pass to humans
(1) Leishmania donovani
(2) Trypanosoma gambiense
(3) Entamoeba histolytica
(4) Plasmodium vivax.

1989

127. Malaria fever coincides with liberation of
(1) cryptomerozoties
(2) metacryptomerozoites
(3) merozoites
(4) trophozoites.

1989

128. The vector for sleeping sickness is
(1) housefly
(2) tse-tse fly
(3) sandfly
(4) fruit fly.

1989

129. The causal organism for African sleeping sickness is
(1) Trypanosoma cruzi
(2) T. rhodesiense
(3) T. tangela
(4) T. gambiense.

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	Column I (Disease)		Column II (Pathogen)
A.	Amoebiasis	(i)	Treponema pallidum
B.	Diphtheria	(ii)	Use only sterilised food and water
C.	Cholera	(iii)	DPT vaccine
D.	Syphilis	(iv)	Use oral rehydration therapy

(1) A - (ii), B - (i), C - (iii), D - (iv)
(2) A - (ii), B - (iii), C - (iv), D - (i)
(3) A - (i), B - (ii), C - (iii), D - (iv)
(4) A - (ii), B - (iv), C - (i), D - (iii)

2008

74. Which one of the following is the correct statement regarding the particular psychotropic drug specified?
(1) Morphine leads to delusions and disturbed emotions.
(2) Barbiturates cause relaxation and temporary euphoria.
(3) Hashish causes after thought perceptions and hallucinations.
(4) Opium stimulates nervous system and causes hallucinations.

2007

75. Increased asthmatic attacks in certain seasons are related to
(1) eating fruits preserved in tin containers
(2) inhalation of seasonal pollen
(3) low temperature
(4) hot and humid environment.

2007

76. Lysozyme that is present in perspiration, saliva and tears, destroys
(1) certain types of bacteria
(2) all viruses
(3) most virus-infected cells
(4) certain fungi.

2006

77. Antibodies in our body are complex
(1) glycoproteins
(2) lipoproteins
(3) steroids
(4) prostaglandins.

2006

78. A person showing unpredictable moods, outbursts of emotion, quarrelsome behaviour and conflicts with others is suffering from
(1) addictive disorders
(2) schizophrenia
(3) borderline personality disorder (BPD)
(4) mood disorders.

NODIA

2005

79. Damage to thymus in a child may lead to
(1) a reduction in haemoglobin content of blood
(2) a reduction in stem cell production
(3) loss of antibody mediated immunity
(4) loss of cell mediated immunity.

2005

80. Which one of the following depresses brain activity and produces feelings of calmness, relaxation and drowsiness?
(1) Morphine
(2) Valium
(3) Amphetamines
(4) Hashish

2004

81. Which one of the following is not correctly matched?
(1) Glossina palpalis - Sleeping sickness
(2) Culex pipiens - Filariasis
(3) Aedes aegypti - Dengue fever
(4) Anopheles culicifacies - Leishmaniasis

2003

82. Short-lived immunity acquired from mother to fetus across placenta or through mother's milk to the infant is categorised as
(1) active immunity
(2) passive immunity
(3) cellular immunity
(4) innate non-specific immunity.

2003

83. Carcinoma refers to
(1) malignant tumours of the connective tissue
(2) malignant tumours of the skin or mucous membrane
(3) malignant tumours of the colon
(4) benign tumours of the connective tissue.

2002

84. Cancerous cells can easily be destroyed by radiations due to
(1) rapid cell division
(2) lack of nutrition
(3) fast mutation
(4) lack of oxygen.

(3) allergic response
(4) graft rejection.

NEET-II 2016

42. Which of the following is correct regarding AIDS causative agent HIV?
(1) HIV is enveloped virus containing one molecule of single-stranded RNA and one molecule of reverse transcriptase.
(2) HIV is enveloped virus that contains two identical molecules of single-stranded RNA and two molecules of reverse transcriptase.
(3) HIV is unenveloped retrovirus.
(4) HIV does not escape but attacks the acquired immune response.

NEET-I 2016

43. Which of the following statements is not true for cancer cells in relation to mutations?
(1) Mutations inactivate the cell control.
(2) Mutations inhibit production of telomerase.
(3) Mutations in proto-oncogenes accelerate the cell cycle.
(4) Mutations destroy telomerase inhibitor.

2015

44. Which of the following diseases is caused by a protozoan?
(1) Babesiosis (2) Blastomycosis
(3) Syphilis (4) Influenza

2015 Cancelled

45. Match each disease with its correct type of vaccine.

	Column I		Column II
A.	Tuberculosis	(i)	Harmless virus
B.	Whooping cough	(ii)	Inactivated toxin
C.	Diphtheria	(iii)	Killed bacteria
D.	Polio	(iv)	Harmless bacteria

(1) A-(iv), B-(iii), C-(ii), D-(i)
(2) A-(i), B-(ii), C-(iv), D-(iii)
(3) A-(ii), B-(i), C-(iii), D-(iv)
(4) A-(iii), B-(ii), C-(iv), D-(i)

2015 Cancelled

46. The active form of Entamoeba histolytica feeds upon
(1) food in intestine
(2) blood only
(3) erythrocytes, mucosa and submucosa of colon
(4) mucosa and submucosa of colon only.

2015, 2007

47. If you suspect major deficiency of antibodies in a person, to which of the following would you look for confirmatory evidence?
(1) Haemocytes
(2) Serum globulins
(3) Fibrinogen in plasma
(4) Serum albumins

2015

48. Which of the following immunoglobulins does constitute the largest percentage in human milk?
(1) IgA (2) IgG
(3) IgD (4) IgM

2015

49. Grafted kidney may be rejected in a patient due to
(1) passive immune response
(2) innate immune response
(3) humoral immune response
(4) cell-mediated immune response.

2015 Cancelled, 2006

50. HIV that causes AIDS, first starts destroying
(1) helper T-lymphocytes
(2) thrombocytes
(3) B-lymphocytes
(4) leucocytes.

2014

51. At which stage of HIV infection does one usually show symptoms of AIDS?
(1) Within 15 days of sexual contact with an infected person
(2) When the infected retro virus enters host cells
(3) When HIV damages large number of helper T - lymphocytes
(4) When the viral DNA is produced by reverse transcriptase

2014

52. Which is the particular type of drug that is obtained from the plant whose one flowering branch is shown here?

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(3) Red and ulcerated skin
(4) Nausea and anaemia

1997

101. If a person shows production of interferons in his body, the chances are that he has got an infection of
(1) tetanus
(2) malaria
(3) typhoid
(4) measles.

1997

102. Which of the following will be curable in next two decades?
(1) Tuberculosis
(2) Cancer
(3) Poliomyelitis
(4) None of these

1997

103. Which of the following is an opiate narcotic?
(1) Amphetamines
(2) LSD
(3) Barbiturates
(4) Morphine

1996

104. Which of the following pair of diseases is caused by virus?
(1) Rabies, mumps
(2) Cholera, tuberculosis
(3) Typhoid, tetanus
(4) AIDS, syphilis

1996

105. Antibodies are produced by
(1) leucocytes
(2) monocytes
(3) lymphocytes
(4) spleen.

1996

106. The interferons are
(1) antigen proteins
(2) antiviral proteins
(3) antibiotic proteins
(4) all of these.

1995

107. Which one of the following pairs is not correctly matched?
(1) Syphilis - Trichuris trichiura
(2) Sleeping sickness - Trypanosoma gambiense
(3) Dengue fever - Arbovirus
(4) Plague - Yersinia pestis

1995

108. Which of the following causes plague?
(1) Trichinella spiralis
(2) Salmonella typhimurium
(3) Yersinia pestis
(4) Leishmania donovani

1995

109. Which one of the following diseases is due to an allergic reaction?
(1) Enteric fever
(2) Skin cancer
(3) Goitre
(4) Hay fever

1995

110. The blood cancer is known as
(1) haemolysis
(2) haemophilia
(3) leukaemia
(4) thrombosis.

1995

111. Nicotine acts as a stimulant, because it mimics the effect of
(1) testosterone
(2) dopamine
(3) thyroxine
(4) acetylcholine.

NODIA

1994

112. Which one of the following does correctly match a sexually transmitted disease with its pathogen?
(1) Syphilis-Treponema pallidum
(2) Gonorrhoea-Entamoeba histolytica
(3) Urethritis-Bacillus anthracis
(4) Softsore-Bacillus brevis

1994

113. Antigens are present
(1) inside the cytoplasm
(2) on nuclear membrane
(3) inside the nucleus
(4) on cell surface.

1994

114. A cell-coded protein that is formed in response to infection, with most animal viruses, is called
(1) histone
(2) antibody
(3) interferon
(4) antigen.

1994

115. A metastatic cancerous tumour is termed 'sarcoma' if the disorder is in
(1) fibroblasts

2001

85. Salmonella is related with
(1) typhoid
(2) polio
(3) T.B.
(4) tetanus.

2001

86. Which is the most infectious disease?
(1) Hepatitis-B
(2) AIDS
(3) Amoebiasis
(4) Malaria

2001

87. Interferons are synthesized in response to
(1) mycoplasma
(2) bacteria
(3) viruses
(4) fungi.

2001

88. Reason of lung cancer is
(1) coal mining
(2) calcium fluoride
(3) cement factory
(4) bauxite mining.

2001

89. Which one of the following is correct match?
(1) Reserpine - tranquilliser
(2) Cocaine - opiatic narcotic
(3) Morphine - hallucinogenic
(4) Bhang - analgesic

2001

90. L.S.D. is
(1) hallucinogenic
(2) sedative
(3) stimulant
(4) tranquilliser.

2000

91. Which is showing accurate pairing?
(1) Syphilis - Treponema pallidum
(2) AIDS - Bacillus conjugalis
(3) Gonorrhoea - Leishmania donovani
(4) Typhoid - Mycobacterium leprae

2000

92. Saline solution is given to patients of cholera because
(1) NA^+ prevents water loss from body
(2) NaCl function as regulatory material
(3) NaCl produces energy
(4) NaCl is antibacterial.

1999

93. The antibodies are
(1) proteins
(2) carbohydrates
(3) lipids
(4) germs.

1999

94. The term 'active immunity' means
(1) increasing rate of heart beat
(2) increasing quantity of blood
(3) resistance developed after disease
(4) resistance developed before disease.

1998

95. Botulism caused by Clostridium botulinum affects the
(1) lymph gland
(2) central nervous system
(3) spleen
(4) intestine.

1998

96. Typhoid fever is caused by
(1) Shigella
(2) Escherichia
(3) Giardia
(4) Salmonella.

1998

97. Human immuno deficiency virus (HIV) has a protein coat and a genetic material which is
(1) double stranded RNA
(2) double stranded DNA
(3) single stranded DNA
(4) single stranded RNA.

1997

98. Diphtheria is caused by
(1) nematodes
(2) bacteria
(3) virus
(4) none of these.

1997

99. Which of the following diseases is now considered completely eradicated from India?
(1) Small pox
(2) Poliomyelitis
(3) Plague
(4) Kala-azar

1997

100. Which of the following symptoms indicate red sickness?
(1) Nausea and loss of hair
(2) Ulcerated skin, nausea and loss of hair

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ANSWERS

1. (1) Morphine
Morphine is an opioid obtained from the latex of the opium poppy and acts as an effective sedative and painkiller. It relieves severe pain such as in post-surgery patients. Anti-retroviral drugs, interferons and antibiotics treat infections, not pain.

2. (1) IgA
Colostrum is the yellowish first milk secreted during early lactation and is rich in antibodies, especially immunoglobulin A (IgA). These antibodies provide passive immunity to the newborn, protecting against infections.

3. (2) Fertilization takes place in mosquito gut
In Plasmodium, the male and female gametes fuse (fertilisation) inside the gut of the female Anopheles mosquito to form a zygote. Gametocytes develop in human RBCs, and the parasite reproduces asexually in liver cells and RBCs, not sexually.

4. (4) (b) and (c) only
Secondary lymphoid organs, where lymphocytes interact with antigens, include spleen, lymph nodes, tonsils, Peyer's patches and appendix. Bone marrow and thymus are primary lymphoid organs where lymphocytes mature. Hence tonsils and spleen are correct.

5. (1) E, D, B, A, C
A female Anopheles mosquito injects sporozoites during a bite (E). These reach the liver through blood (D) and multiply asexually in liver cells (B). The parasites then multiply asexually in RBCs, rupturing them (A) and finally gametocytes develop within the red blood cells (C), giving E, D, B, A, C.

6. (3) A-II, B-III, C-IV, D-I
Nicotine stimulates the adrenal gland to release catecholamines into the blood (II). Morphine is an effective sedative and painkiller (III). Heroin is a depressant that slows down body functions (IV). Cocaine causes a sense of euphoria and increased energy (I), giving A-II, B-III, C-IV, D-I.

7. (2) C, D, E only
Primary lymphoid organs like the bone marrow and thymus are where immature lymphocytes differentiate into antigen-sensitive cells. Once mature, these lymphocytes travel through the blood to secondary lymphoid organs. These include the spleen, lymph nodes, and Peyer's patches. These specific sites provide the necessary environment where lymphocytes can actively interact with antigens to initiate immune responses.

8. (4) Innate Immunity
Innate immunity represents a non-specific defense mechanism that is functionally active from the moment of birth. It consists of various barriers, including physical, physiological, cellular, and cytokine barriers, which prevent the entry or spread of foreign agents. This system provides an immediate but generalized response against a wide range of pathogens without requiring any prior exposure or memory.

9. (1) Antigen binding site is located at C-terminal region of antibody molecules.
Antibody molecules consist of four polypeptide chains, two light and two heavy, held together by disulfide bonds. Each chain has a variable region and a constant region. The antigen-binding site, also known as the paratope, is specifically located at the N-terminal region of the variable domains. The C-terminal region contains the constant domains that determine biological activity.

10. (4) A, B, C only
Neoplastic cells are characterized by their ability to undergo uncontrolled and rapid cell division, leading to the formation of a mass of proliferating cells. These malignant cells lack contact inhibition and possess the capacity to invade and damage surrounding tissues. Unlike benign tumors, which remain confined to their original location, neoplastic growths frequently exhibit metastasis to distant body parts.

11. (2) A and C only
Computed tomography and magnetic resonance imaging are advanced diagnostic techniques used to detect internal cancers. Biological response

NODIA

(3) Spleen of infected humans
(4) Salivary glands of freshy moulted female Anopheles mosquito

Mains 2011

63. Which one of the following options gives the correct match of a disease with its causative organism and mode of infection?

	Disease	**Causative organism**	**Mode of infection**
(1)	Typhoid	Salmonella typhi	With inspired air
(2)	Pneumonia	Streptococcus pneumoniae	Droplet infection
(3)	Elephantiasis	Wuchereria bancrofti	With infected water and food
(4)	Malaria	Plasmodium vivax	Bite of male Anopheles mosquito

Mains 2011

64. Common cold is not cured by antibiotics because it is
(1) caused by a virus
(2) caused by a Gram-positive bacterium
(3) caused by a Gram-negative bacterium
(4) not an infectious disease.

2010

65. Ringworm in humans is caused by
(1) bacteria
(2) fungi
(3) nematodes
(4) viruses.

2010

66. Widal test is used for the diagnosis of
(1) malaria
(2) pneumonia
(3) tuberculosis
(4) typhoid.

Mains 2010

67. A person suffering from a disease caused by Plasmodium, experiences recurring chill and fever at the time when
(1) the sporozoites released from RBCs are being rapidly killed and broken down inside spleen
(2) the trophozoites reach maximum growth and give out certain toxins
(3) the parasite after its rapid multiplication inside RBCs ruptures them, releasing the stage to enter fresh RBCs
(4) the microgametocytes and megagametocytes are being destroyed by the WBCs.

2010

68. Which one of the following statements is correct with respect to AIDS?
(1) The HIV can be transmitted through eating food together with an infected person.
(2) Drug addicts are least susceptible to HIV infection.
(3) AIDS patients are being fully cured cent per cent with proper care and nutrition.
(4) The causative HIV retrovirus enters helper T-lymphocytes thus reducing their numbers.

Mains 2010

69. Which one of the following techniques is safest for the detection of cancers?
(1) Magnetic resonance imaging (MRI)
(2) Radiography (X-ray)
(3) Computed tomography (CT)
(4) Histopathological studies

2010

70. Select the correct statement from the ones given below.
(1) Barbiturates, when given to criminals, make them tell the truth.
(2) Morphine is often given to persons, who have undergone surgery, as a pain killer.
(3) Chewing tobacco lowers blood pressure and heart rate.
(4) Cocaine is given to patients after surgery as it stimulates recovery.

2009

71. Which of the following is a pair of viral diseases?
(1) Common cold, AIDS
(2) Dysentery, common cold
(3) Typhoid, tuberculosis
(4) Ringworm, AIDS

2009

72. Which one of the following statements is correct?
(1) Benign tumours show the property of metastasis.
(2) Heroin accelerates body functions.
(3) Malignant tumours may exhibit metastasis.
(4) Patients who have undergone surgery are given cannabinoids to relieve pain.

2008

73. Match the disease in column I with the appropriate items (pathogen / prevention / treatment) in column II.

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tears and saliva that inhibit microbial growth through chemical means. Physical barriers, like the mucus coating of the respiratory tract, mechanically prevent pathogens from entering the human body.

21. (3) TH cells
The Human Immunodeficiency Virus primarily targets helper T-lymphocytes, also known as TH cells, which possess CD4 receptors. Once inside these cells, the virus uses reverse transcriptase to convert its RNA into DNA. This viral DNA integrates into the host genome to direct the production of new virus particles. The continuous replication eventually leads to a depletion of these cells.

22. (4) smack.
Diacetylmorphine is a powerful opioid drug commonly known by the street name smack. It is chemically synthesized through the acetylation of morphine, which is extracted from the latex of the poppy plant, Papaver somniferum. This substance acts as a depressant and significantly slows down various body functions. It is typically a white, odorless, bitter crystalline compound with high addictive potential.

23. (3) A-II, B-I, C-IV, D-III
Heroin is a depressant that significantly slows down normal body functions. Cannabinoids like marijuana are known for their specific effects on the human cardiovascular system. Cocaine interferes with the transport of the neurotransmitter dopamine, leading to increased stimulation and euphoria. Morphine is a very effective painkiller and sedative, often used in medical settings to manage severe physical pain.

24. (3) Statement I is correct but Statement II is incorrect
An autoimmune disorder occurs when the immune system loses its ability to distinguish self-cells from non-self entities, leading it to attack the body's own tissues. Rheumatoid arthritis is a classic example of this condition, as the immune system mistakenly targets the joints. Therefore, the assertion that the body does not attack self-cells in rheumatoid arthritis is scientifically inaccurate.

25. (4) Acquired immunity is non-specific type of defense present at the time of birth.
Acquired immunity is a pathogen-specific defense mechanism that develops during an individual's lifetime following exposure to foreign agents. It is characterized by memory, allowing for a rapid and heightened anamnestic response upon subsequent encounters with the same pathogen. In contrast, innate immunity is the non-specific defense present from birth, consisting of various physical, chemical, and cellular barriers.

26. (3) (iii) (iv) (i) (ii)
Filariasis is caused by the nematode Wuchereria bancrofti, while amoebiasis is triggered by the protozoan Entamoeba histolytica. Pneumonia is a bacterial infection commonly caused by Haemophilus influenzae. Ringworm is a fungal disease associated with genera like Trichophyton. These infectious diseases are characterized by unique modes of transmission and specific clinical symptoms that aid in their diagnosis and medical management.

27. (2) Sporozoites
The life cycle of Plasmodium involves two hosts, humans and female Anopheles mosquitoes. When an infected mosquito bites a human, it injects the parasite in the form of sporozoites. These sporozoites are the infectious stage that first migrates to the liver cells for initial multiplication before entering the red blood cells to continue the cycle and cause disease symptoms.

28. (2) (iii) (iv) (i) (ii)
Typhoid is a bacterial infection caused by Salmonella typhi. Pneumonia is frequently caused by bacteria such as Haemophilus influenzae. Filariasis is a condition resulting from infection by the filarial worm Wuchereria bancrofti. Malaria is caused by protozoan parasites of the genus Plasmodium. Each causative organism utilizes different mechanisms to infect the host and produce the characteristic clinical symptoms of these diseases.

29. (3) Active immunity is quick and gives full response.
Active immunity occurs when a host is exposed to antigens, leading to the internal production of antibodies. This process is generally slow and takes time to develop a full, effective response. In contrast, passive immunity involves the direct administration of preformed antibodies,

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67. (3) the parasite after its rapid multiplication inside RBCs ruptures them, releasing the stage to enter fresh RBCs
In the malarial life cycle, parasites multiply asexually within human red blood cells. When these infected cells eventually rupture, they release a new generation of parasites along with a toxic substance called haemozoin. The sudden release of this toxin into the bloodstream triggers the characteristic clinical symptoms of malaria, which include recurring bouts of high fever and shivering chills every few days.

68. (4) The causative HIV retrovirus enters helper T-lymphocytes thus reducing their numbers.
HIV is a retrovirus that targets the human immune system by specifically infecting helper T-lymphocytes. Once inside, the virus replicates and eventually causes the death of these essential cells. This progressive reduction in the T-cell count severely compromises the host's ability to mount an effective immune response. AIDS cannot be transmitted through casual contact like sharing food or eating together with an infected person.

69. (1) Magnetic resonance imaging (MRI)
Magnetic resonance imaging is considered the safest technique for detecting internal cancers because it does not use ionizing radiation. Instead, it utilizes strong magnetic fields and radio waves to generate highly detailed images of soft tissues. In contrast, techniques like radiography and computed tomography involve exposure to X-rays, which can potentially damage DNA if used excessively or without proper medical precautions.

70. (2) Morphine is often given to persons, who have undergone surgery, as a pain killer.
Morphine is a powerful opioid analgesic derived from the poppy plant. In clinical medicine, it is frequently administered to patients who have undergone major surgical procedures because of its exceptional ability to suppress intense physical pain. While it is a highly effective sedative and painkiller, it must be used under strict medical supervision due to the risks of respiratory depression and potential dependency.

71. (1) Common cold, AIDS
The common cold and AIDS are both diseases caused by viral pathogens. Rhinoviruses are the primary cause of the common cold, affecting the upper respiratory tract. Acquired Immunodeficiency Syndrome is caused by the Human Immunodeficiency Virus, which targets and weakens the immune system. Other diseases like typhoid, tuberculosis, and syphilis are bacterial, while ringworm is a fungal infection, and dysentery can be bacterial.

NODIA

72. (3) Malignant tumours may exhibit metastasis.
Malignant tumors are characterized by rapid, uncontrolled cell growth and the ability to invade surrounding tissues. A defining feature of these tumors is metastasis, where cancerous cells break away and travel through the blood or lymph to establish secondary tumors in distant organs. In contrast, benign tumors remain localized. Heroin is a depressant, and morphine, rather than cannabinoids, is typically used for post-surgical pain.

73. (2) A - (ii), B - (iii), C - (iv), D - (i)
Amoebiasis is prevented by maintaining strict hygiene and using sterilized food and water. Diphtheria is a bacterial disease effectively prevented through the administration of the DPT vaccine. Cholera treatment frequently involves oral rehydration therapy to manage severe dehydration caused by diarrhea. Syphilis is a sexually transmitted infection caused by the bacterium Treponema pallidum. These pairings reflect established medical knowledge regarding disease management.

74. (3) Hashish causes after thought perceptions and hallucinations.
Hashish is a psychoactive drug derived from the Cannabis sativa plant. It contains cannabinoids that affect the central nervous system, leading to altered sensory perceptions and hallucinations. Morphine primarily acts as a sedative and analgesic rather than causing delusions. Barbiturates are central nervous system depressants that induce sleep and reduce anxiety. Opium is a natural source of narcotics that generally slows down body functions rather than stimulating them.

75. (2) inhalation of seasonal pollen
Asthma is a chronic inflammatory condition of the airways that is often triggered by allergens. In many regions, the concentration of airborne pollen increases during specific seasons as plants flower. When susceptible individuals inhale these seasonal pollens, it triggers an allergic reaction

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contaminated water. Tetanus is a serious nervous system disorder caused by the toxin-producing bacterium Clostridium tetani. Both diseases are purely bacterial in origin. In contrast, smallpox, mumps, herpes, and influenza are caused by various viruses, which require different biological approaches for prevention and medical treatment.

40. (2) attenuated pathogens
Antivenom provides immediate protection through passive immunization by injecting preformed antibodies. Polio drops, used in oral vaccination, contain live but attenuated pathogens. These weakened viruses are unable to cause the full disease but are sufficient to stimulate the host's immune system to produce its own antibodies and memory cells. This process provides long-lasting active immunity against future polio infections.

41. (1) autoimmune disease
In higher vertebrates, the immune system normally possesses the critical ability to distinguish between self-cells and foreign non-self entities. If a genetic abnormality or environmental factor causes the immune system to lose this discrimination, it may begin attacking the body's own tissues. This pathological state is known as an autoimmune disease, which can result in various chronic inflammatory conditions and tissue damage.

42. (2) HIV is enveloped virus that contains two identical molecules of single-stranded RNA and two molecules of reverse transcriptase.
The Human Immunodeficiency Virus is a specialized retrovirus characterized by a lipid envelope. Its genetic core consists of two identical strands of single-stranded RNA. Accompanying the viral genome are two molecules of the enzyme reverse transcriptase, which facilitates the conversion of viral RNA into DNA inside the host cell. This structure is essential for the virus to replicate within human helper T-lymphocytes.

43. (2) Mutations inhibit production of telomerase.
Cancer cells are characterized by their ability to divide indefinitely, often due to mutations that increase telomerase production. Telomerase maintains the length of chromosomes, preventing the normal cellular aging process and programmed death. In malignant cells, mutations typically accelerate the cell cycle by activating proto-oncogenes or inactivating tumor suppressors. Therefore, the inhibition of telomerase production is not a characteristic associated with cancer development.

44. (1) Babesiosis
Babesiosis is a malaria-like parasitic disease caused by protozoans of the genus Babesia, which are typically transmitted through tick bites. These parasites infect and destroy red blood cells in the host. In contrast, blastomycosis is a fungal infection, syphilis is a sexually transmitted bacterial disease caused by Treponema pallidum, and influenza is a common respiratory illness caused by the influenza virus.

45. (1) A-(iv), B-(iii), C-(ii), D-(i)
Vaccination strategies utilize different types of antigenic preparations. Tuberculosis is prevented using the BCG vaccine, which contains harmless, live bacteria. Whooping cough is treated with vaccines containing killed bacteria. Diphtheria prevention involves using an inactivated toxin known as a toxoid to stimulate immunity. Polio vaccination traditionally utilizes harmless, attenuated viruses to provoke a protective immune response in the recipient's body.

46. (3) erythrocytes, mucosa and submucosa of colon
Entamoeba histolytica is a protozoan parasite that causes amoebiasis in the large intestine. The trophozoite, which is the active and motile stage, invades the intestinal wall. It feeds on the red blood cells, as well as the mucosa and submucosa of the colon, leading to characteristic ulcers. This tissue destruction results in symptoms like abdominal pain, constipation, and stools containing excess mucus and blood.

47. (2) Serum globulins
Antibodies are specialized proteins known as immunoglobulins that circulate in the blood plasma. If a patient is suspected of having a major deficiency in antibody production, clinicians analyze the serum globulin fraction of the blood. Since antibodies constitute a significant portion of gamma globulins, a reduction in these levels serves as confirmatory evidence for an impaired humoral immune response or immunodeficiency.

48. (1) IgA
Human milk, especially the early colostrum, contains high concentrations of antibodies that provide passive immunity to the nursing infant. Immunoglobulin A is the most abundant

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ionizing radiation. Radiotherapy exploits this vulnerability by focusing high-energy rays on the tumor, which disrupts the DNA of the dividing cells. Because cancerous cells divide much faster than most normal cells, they are more easily destroyed by such targeted treatments.

85. (1) typhoid
Salmonella typhi is the specific bacterial pathogen responsible for causing typhoid fever in humans. This bacterium is typically transmitted through the consumption of contaminated food or water. Once ingested, it enters the small intestine and migrates into the bloodstream. Symptoms of the resulting infection include high fever, weakness, stomach pain, and headache. The diagnosis is commonly confirmed using serological tests like the Widal test.

86. (1) Hepatitis-B
Hepatitis-B is a highly infectious viral disease that affects the liver. It is transmitted through contact with infected blood or other body fluids. Compared to HIV, the Hepatitis-B virus is significantly more resilient and can survive outside the body for longer periods. It is also more easily transmitted through minor exposures. Vaccination is a highly effective way to prevent this serious and potentially chronic infectious condition.

87. (3) viruses
Interferons are a group of signaling proteins synthesized and secreted by host cells in response to the presence of viruses. When a cell becomes infected by a virus, it releases interferons to warn neighboring uninfected cells. These neighboring cells then produce antiviral proteins that inhibit viral replication. This mechanism forms a critical cytokine barrier in the body's innate immune system, helping to contain the spread of viral infections.

88. (1) coal mining
Lung cancer can be caused by various environmental and occupational factors. Coal mining is a well-known risk factor because miners are frequently exposed to coal dust, radon gas, and other particulate matter. Inhaling these substances over long periods can lead to chronic inflammation and genetic damage in lung tissues, significantly increasing the probability of developing malignant tumors. Other common causes of lung cancer include tobacco smoking and air pollution.

89. (1) Reserpine - tranquilliser
Reserpine is a naturally occurring alkaloid derived from the roots of the plant Rauwolfia serpentina. It was historically used as a tranquilizer and antipsychotic medication to treat symptoms of mental agitation and high blood pressure. In contrast, cocaine is a stimulant, morphine is a potent analgesic and sedative rather than purely hallucinogenic, and bhang is a preparation of cannabis that acts primarily as a psychoactive substance.

90. (1) hallucinogenic
Lysergic acid diethylamide, commonly abbreviated as LSD, is a powerful psychoactive drug. It is classified as a hallucinogen because it dramatically alters an individual's sensory perceptions, thoughts, and emotions. Users may experience vivid visual hallucinations and a distorted sense of time and space. LSD is derived from lysergic acid found in ergot fungi. It does not act as a sedative or stimulant in the traditional pharmacological sense.

91. (1) Syphilis - Treponema pallidum
Syphilis is a sexually transmitted bacterial infection caused by the spirochete Treponema pallidum. This pairing is medically accurate. In contrast, AIDS is caused by the Human Immunodeficiency Virus, gonorrhoea is caused by the bacterium Neisseria gonorrhoeae, and typhoid is caused by Salmonella typhi. Understanding the correct pathogen associated with each disease is fundamental for accurate diagnosis and the selection of appropriate antimicrobial or antiviral therapies.

92. (1) NA^+ prevents water loss from body
Cholera is a bacterial infection that causes severe watery diarrhea, leading to rapid dehydration and loss of essential electrolytes. Administering a saline solution helps to replenish lost fluids and salts. Specifically, sodium ions play a crucial role in maintaining osmotic balance and promoting the absorption of water in the intestines. This rehydration therapy is vital for preventing the life-threatening complications associated with extreme fluid loss in cholera patients.

NODIA

58. (4) pneumonia pathogen infects alveoli whereas the common cold affects nose and respiratory passage but not the lungs.
Pneumonia and the common cold are both respiratory infections but differ in the specific areas they target. Pneumonia is a serious condition where pathogens like Streptococcus pneumoniae infect the alveoli of the lungs, causing them to fill with fluid. The common cold, caused primarily by rhinoviruses, is localized to the nose and upper respiratory passages, generally sparing the lungs themselves.

59. (4) They show contact inhibition.
Normal cells exhibit a property called contact inhibition, where their growth stops when they come into contact with other cells. Cancerous cells lose this critical regulatory mechanism, allowing them to divide in an uncontrolled manner and form masses called tumors. These cells also compete with normal cells for essential nutrients and possess the ability to migrate and invade distant tissues through metastasis.

60. (2) alcohol
Cirrhosis of the liver is a chronic condition characterized by the replacement of healthy liver tissue with non-functional scar tissue. The primary cause of this disease is the long-term, excessive consumption of alcohol. Chronic intake of ethanol leads to metabolic disturbances and direct damage to hepatocytes. Over time, this results in the progressive loss of liver function, which can lead to severe health complications.

61. (4)
Morphine is a naturally occurring alkaloid extracted from the latex of the poppy plant, Papaver somniferum. It is clinically utilized as a potent sedative and analgesic to manage intense pain, especially in patients who have undergone major surgery. While it is highly effective for medical pain relief, its use must be carefully monitored due to its high potential for addiction and respiratory depression.

62. (1) Saliva of infected female Anopheles mosquito
Sporozoites represent the infectious stage of the malarial parasite Plasmodium. After multiplying within the oocysts on the mosquito's gut wall, the sporozoites migrate to the salivary glands of the female Anopheles mosquito. When the mosquito bites a human host to take a blood meal, these sporozoites are injected along with its saliva into the human bloodstream, initiating a new infection.

63. (2) Pneumonia Streptococcus pneumoniae Droplet infection
Pneumonia is an infectious disease primarily caused by the bacterium Streptococcus pneumoniae. It is typically transmitted through droplet infection, which occurs when an infected person coughs or sneezes, releasing pathogens into the air. In contrast, typhoid is spread through contaminated food and water, elephantiasis is transmitted by mosquito bites, and malaria is spread specifically by the bite of an infected female Anopheles mosquito.

64. (1) caused by a virus
Antibiotics are drugs designed to target and inhibit the metabolic pathways or structural components of bacteria, such as cell wall synthesis. The common cold is caused by a group of viruses, most notably rhinoviruses. Since viruses lack the specific biological targets that antibiotics act upon, these medications are ineffective against viral infections. Proper treatment for the common cold usually involves managing symptoms.

65. (2) fungi
Ringworm, also known as tinea, is a common skin infection characterized by itchy, red, circular lesions. Despite its name, it is not caused by worms but by several genera of fungi, including Microsporum, Trichophyton, and Epidermophyton. These fungi thrive in warm, moist areas and are transmitted through direct contact with infected individuals, animals, or contaminated objects like towels and combs.

66. (4) typhoid.
Typhoid fever is a bacterial infection caused by Salmonella typhi, which enters the body through contaminated food and water. Clinicians use the Widal test as a standard serological tool to diagnose this condition. The test detects the presence of specific antibodies in the patient's blood that react with the bacterial antigens, providing a reliable method for confirming the infection in clinical settings.

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providing immediate protection. An example of passive immunity is a fetus receiving essential antibodies from the mother via the placenta.

30. (1) Salmonella typhi / Widal test
Typhoid fever is a systemic bacterial infection caused by the pathogen Salmonella typhi. It is typically transmitted through contaminated food and water. Clinically, the disease is confirmed using the Widal test, which detects specific antibodies against the somatic and flagellar antigens of the bacteria. This serological test remains a standard diagnostic tool for identifying typhoid in many clinical settings worldwide.

31. (1) Cell-mediated immune response
The rejection of a kidney graft or any transplanted organ is primarily mediated by the cell-mediated immune response. T-lymphocytes play a crucial role in recognizing the transplanted tissue as non-self and initiating an attack against the foreign cells. Because of this response, tissue matching and the use of immunosuppressant drugs are necessary to improve the chances of successful organ transplantation.

32. (1) immunoglobulin A
Colostrum is the specialized milk produced by mothers during the first few days after delivery. It is exceptionally rich in antibodies, specifically Immunoglobulin A, which provide crucial passive immunity to the newborn infant. These antibodies protect the infant's digestive and respiratory tracts from various pathogens while their own immune system is still developing, ensuring a healthy start during early life.

33. (3) acetylation of morphine
Heroin, chemically known as diacetylmorphine, is a semi-synthetic opioid produced through the chemical acetylation of morphine. Morphine is naturally extracted from the latex of the opium poppy, Papaver somniferum. The addition of acetyl groups increases the lipid solubility of the molecule, allowing it to cross the blood-brain barrier more rapidly. This drug acts as a potent central nervous system depressant.

34. (1) Elephantiasis
Elephantiasis, also known as lymphatic filariasis, is caused by the nematode parasites Wuchereria bancrofti and Wuchereria malayi. These pathogens are transmitted through the bite of infected mosquitoes. The worms reside in the lymphatic vessels, causing chronic inflammation and blockage. Over time, this leads to severe swelling of the limbs or genital organs, which is the hallmark clinical feature of the disease.

35. (3) Alzheimer's disease
Autoimmune diseases occur when the immune system mistakenly attacks healthy cells, as seen in psoriasis, rheumatoid arthritis, and vitiligo. These conditions involve the loss of self-tolerance. Alzheimer's disease, however, is a progressive neurodegenerative disorder primarily associated with the accumulation of amyloid plaques and tau tangles in the brain. It is not classified as an autoimmune condition involving the immune system's self-destruction.

NODIA

36. (2) Latex
The drug commonly known as smack or heroin is derived from morphine, which is extracted from the poppy plant, Papaver somniferum. Specifically, it is the milky exudate or latex obtained by incising the unripe seed pods of the plant. This latex contains various alkaloids that are processed to produce sedative and analgesic substances, which act as central nervous system depressants.

37. (1) Cell-mediated immune response
Organ transplantation failure is frequently caused by the body's immune system identifying the graft as a foreign entity. The cell-mediated immune response, driven by T-lymphocytes, is specifically responsible for this recognition and the subsequent rejection of non-self tissues. To prevent this, doctors perform tissue typing and cross-matching, and patients often require long-term immunosuppressive therapy to ensure the survival of the transplant.

38. (4) 50%
Mucosa-associated lymphoid tissue is located within the linings of the major tracts of the human body, including the respiratory, digestive, and urogenital systems. It serves as a critical component of the secondary lymphoid system, providing a first line of defense against inhaled or ingested pathogens. In humans, this specialized tissue accounts for approximately fifty percent of the total lymphoid tissue.

39. (1) Cholera and tetanus
Cholera is an acute intestinal infection caused by the bacterium Vibrio cholerae, typically through

and bronchoconstriction. This leads to increased asthmatic attacks characterized by wheezing, coughing, and difficulty breathing during those particular times of the year.

76. (1) certain types of bacteria
Lysozyme is a protective enzyme found in various human bodily fluids, including perspiration, saliva, and tears. It acts as a primary chemical barrier against infection by targeting the cell walls of certain types of bacteria. By catalyzing the hydrolysis of the peptidoglycan layer, lysozyme causes the bacterial cells to burst. This enzymatic activity is a vital component of the body's innate immune defense.

77. (1) glycoproteins
Antibodies, also known as immunoglobulins, are complex molecules synthesized by B-lymphocytes in response to foreign antigens. Chemically, these molecules are classified as glycoproteins, consisting of polypeptide chains with attached carbohydrate groups. They feature a specific structure with two heavy and two light chains. Their primary function is to recognize and neutralize pathogens like bacteria and viruses to protect the body from various infectious diseases.

78. (3) borderline personality disorder (BPD)
Borderline personality disorder is a mental health condition characterized by significant instability in moods, self-image, and interpersonal relationships. Individuals suffering from this disorder often experience unpredictable emotional outbursts, intense anger, and chronic conflicts with others. These behavioral patterns lead to a cycle of unstable relationships and impulsive actions. It is distinct from other conditions like schizophrenia or simple mood disorders based on these specific personality traits.

79. (4) loss of cell mediated immunity.
The thymus is a primary lymphoid organ where T-lymphocytes undergo essential maturation and differentiation. During this process, they become immunocompetent and learn to distinguish self from non-self. If the thymus is damaged in a child, the production and maturation of functional T-cells are severely impaired. This leads to a profound loss of cell-mediated immunity, making the individual highly vulnerable to intracellular pathogens and cancers.

80. (2) Valium
Valium is a commercial brand name for diazepam, a drug belonging to the benzodiazepine class. It acts as a central nervous system depressant by enhancing the effects of inhibitory neurotransmitters in the brain. This results in significant feelings of calmness, relaxation, and drowsiness. While morphine is an analgesic and amphetamines are stimulants, Valium is primarily used to treat anxiety, muscle spasms, and seizure disorders.

81. (4) Anopheles culicifacies - Leishmaniasis
Leishmaniasis is a parasitic disease caused by protozoans of the genus Leishmania. It is transmitted to humans through the bite of infected female sandflies, specifically from the genus Phlebotomus. Anopheles mosquitoes are the primary vectors for malaria, not leishmaniasis. Other matches are correct: Glossina transmits sleeping sickness, Culex mosquitoes transmit filariasis, and Aedes aegypti is the well-known vector for dengue fever and yellow fever.

82. (2) passive immunity.
Passive immunity involves the transfer of preformed antibodies from one individual to another, providing immediate but short-lived protection. Natural examples of this include the transfer of IgG antibodies from a mother to her fetus across the placenta and the provision of IgA antibodies through breast milk. This is crucial for protecting the infant during the early stages of life while their own immune system is still developing.

83. (2) malignant tumours of the skin or mucous membrane
Carcinoma is a specific type of cancer that originates in epithelial tissues, which cover the internal and external surfaces of the body. This includes the skin and the mucous membranes lining various organs. These malignant tumors are the most common form of cancer. In contrast, sarcomas arise from connective tissues like bone and muscle, while benign tumors are non-cancerous growths that do not invade surrounding tissues.

84. (1) rapid cell division
Cancer cells are characterized by their ability to undergo continuous and rapid cell division. This high metabolic and mitotic activity makes them particularly sensitive to damage from

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suggests a viral infection like measles, rather than bacterial or protozoan infections such as tetanus, malaria, or typhoid.

102. (3) Poliomyelitis
Poliomyelitis is a viral disease that can cause irreversible paralysis. Due to the highly effective global polio eradication initiative, which uses both oral and inactivated polio vaccines, the incidence of the disease has dropped significantly. Modern public health efforts continue to target the complete eradication of the virus. Because of these intensive vaccination programs, medical experts remain optimistic about eliminating polio globally in the relatively near future, following the success of smallpox.

103. (4) Morphine
Morphine is a naturally occurring alkaloid obtained from the opium poppy and is classified as an opiate narcotic. It acts directly on the central nervous system to relieve intense pain and induce sedation. While highly effective for medical use, it carries a significant risk of addiction. In contrast, amphetamines are stimulants, LSD is a powerful hallucinogen, and barbiturates are synthetic depressants primarily used as sedatives or anticonvulsants rather than being derived from opium.

104. (1) Rabies, mumps
Both rabies and mumps are infectious diseases caused by specific viral pathogens. Rabies is a fatal viral disease transmitted through the saliva of infected animals, while mumps is a contagious viral infection primarily affecting the salivary glands. Other pairs mentioned include bacterial diseases like cholera, tuberculosis, typhoid, tetanus, and syphilis, or a combination of viral and bacterial infections. Distinguishing between viral and bacterial causes is critical for appropriate medical treatment.

105. (3) lymphocytes
Antibodies are specialized defensive proteins produced by a specific type of white blood cell known as B-lymphocytes. When these cells encounter a foreign antigen, they differentiate into plasma cells, which then secrete large quantities of antibodies into the blood and lymph. These antibodies specifically target and neutralize the invading pathogens. This process is a fundamental component of the adaptive immune system, providing targeted protection against various bacteria and viruses.

106. (2) antiviral proteins
Interferons are classified as antiviral proteins that are synthesized and released by host cells in response to viral infections. They do not directly kill viruses but instead signal uninfected cells to produce protective proteins that inhibit the replication of viral genetic material. This mechanism creates a cytokine barrier that helps limit the spread of viruses within the body. Interferons are an essential part of the innate, non-specific immune defense system in vertebrates.

NODIA

107. (1) Syphilis - Trichuris trichiura
Syphilis is a sexually transmitted infection caused by the bacterium Treponema pallidum, not by the parasitic whipworm Trichuris trichiura. The other pairings provided are scientifically accurate. Sleeping sickness is caused by the protozoan Trypanosoma gambiense. Dengue fever is a viral disease caused by an arbovirus and transmitted by mosquitoes. Plague is a serious bacterial infection caused by Yersinia pestis. Correct identification of these causative agents is essential for proper medical diagnosis.

108. (3) Yersinia pestis
Plague is a severe infectious disease caused by the gram-negative bacterium Yersinia pestis. It is primarily a zoonotic disease of rodents, transmitted to humans through the bite of infected rat fleas. There are several forms of the disease, including bubonic, septicemic, and pneumonic plague. In contrast, Salmonella causes typhoid, Leishmania causes kala-azar, and Trichinella is a parasitic worm. Throughout history, plague has caused several devastating global pandemics.

109. (4) Hay fever
Hay fever, also known as allergic rhinitis, is an exaggerated immune response to environmental allergens such as pollen, dust, or animal dander. This allergic reaction involves the release of histamine from mast cells, leading to symptoms like sneezing, itchy eyes, and a runny nose. Unlike goitre which is a thyroid condition, skin cancer which is neoplastic, or enteric fever which is bacterial, hay fever is purely a hypersensitivity disorder of the immune system.

93. (1) proteins
Antibodies, also referred to as immunoglobulins, are specialized molecules produced by B-lymphocytes in the immune system. Chemically, these molecules consist of four polypeptide chains arranged in a Y-shaped structure, making them purely proteinaceous in nature. Their primary function is to identify and bind to specific antigens on pathogens like bacteria and viruses. This binding marks the foreign invaders for destruction by other components of the immune system.

94. (3) resistance developed after disease
Active immunity refers to the type of resistance that an individual develops when their own immune system is stimulated by an antigen. This naturally occurs after a person recovers from an infectious disease or is artificially induced through vaccination. During this process, the body produces its own antibodies and memory cells. This form of immunity is typically long-lasting and provides protection against future encounters with the same specific pathogen.

95. (2) central nervous system
Botulism is a rare but very serious paralytic illness caused by a nerve toxin produced by the bacterium Clostridium botulinum. This potent neurotoxin primarily affects the nervous system by blocking the release of acetylcholine at neuromuscular junctions. This leads to progressive muscle weakness and potential respiratory failure. Common sources of the bacteria include improperly canned or preserved foods where anaerobic conditions allow the bacteria to grow.

96. (4) Salmonella.
Typhoid fever is a systemic infection caused by the gram-negative bacterium Salmonella typhi. The disease is primarily transmitted through the consumption of food or water contaminated with the feces of an infected individual. Once inside the host, the bacteria multiply in the small intestine and then spread to the bloodstream and other organs. Effective prevention strategies focus on improving sanitation, food safety, and the administration of available typhoid vaccines.

97. (4) single stranded RNA.
The Human Immunodeficiency Virus belongs to the family of retroviruses. Its structure consists of a protective protein coat, or capsid, which encloses its genetic material. The HIV genome is composed of two identical molecules of single-stranded RNA. Along with the RNA, the virus carries essential enzymes like reverse transcriptase, which allows it to convert its viral RNA into DNA once it has entered a host's helper T-lymphocyte.

98. (2) bacteria
Diphtheria is an acute and highly contagious respiratory disease caused by the bacterium Corynebacterium diphtheriae. This pathogen typically infects the throat and nose, producing a characteristic thick, gray membrane. The bacteria also release a potent toxin that can spread through the bloodstream, potentially damaging the heart and nervous system. The disease is effectively controlled in many parts of the world through widespread immunization programs using the DPT vaccine.

99. (1) Small pox
Smallpox is a serious infectious disease caused by the variola virus. Following a massive and successful global vaccination campaign led by the World Health Organization, it became the first human disease to be completely eradicated from the world. India was officially declared free of smallpox in the late nineteen seventies. Since then, no naturally occurring cases have been reported, making it a landmark achievement in the history of public health.

NODIA

100. (2) Ulcerated skin, nausea and loss of hair
Radiation sickness, sometimes referred to as red sickness due to skin inflammation, occurs following exposure to high doses of ionizing radiation. The condition is characterized by several acute symptoms. Nausea and vomiting are common early signs, while damage to rapidly dividing cells leads to significant hair loss. Additionally, the skin can become severely reddened and ulcerated. These symptoms reflect the systemic damage caused to various tissues and the immune system.

101. (4) measles.
Interferons are specialized antiviral proteins produced by host cells when they are infected by a virus. They serve as part of the innate immune response by inhibiting viral replication in neighboring healthy cells. Measles is a highly contagious disease caused by a virus. Therefore, the presence of interferons in a person's body

antibody type found in these secretions. It plays a vital role in protecting the newborn's intestinal and respiratory mucosa from pathogens. This maternal transfer of IgA is essential for strengthening the infant's defense system during early development.

49. (4) cell-mediated immune response.
When an organ like a kidney is grafted into a patient, the immune system must recognize it as self to avoid rejection. The cell-mediated immune response, primarily involving T-lymphocytes, is responsible for identifying and attacking the foreign tissues of the graft. To minimize this risk, doctors perform careful tissue matching and use immunosuppressive drugs to dampen this specific immune reaction.

50. (1) helper T-lymphocytes
Upon entering the human body, the Human Immunodeficiency Virus acts as a retrovirus that primarily targets the immune system. It specifically seeks out and infects helper T-lymphocytes, which play a central role in coordinating the immune response. By replicating within these cells and eventually destroying them, the virus progressively weakens the host's immunity, making them susceptible to various opportunistic infections.

51. (3) When HIV damages large number of helper T - lymphocytes
HIV infection progresses through various stages before reaching Acquired Immunodeficiency Syndrome. Symptoms usually manifest when the viral replication has significantly depleted the population of helper T-lymphocytes. As these critical immune cells are destroyed, the body loses its ability to fight off common pathogens. This severe immunodeficiency allows opportunistic infections and cancers to develop, marking the clinical onset of the disease symptoms.

52. (1) Hallucinogen
The flowering branch depicted is from the Datura plant, which is known for its potent psychoactive properties. This plant contains alkaloids like atropine and scopolamine that interfere with neurotransmission in the brain. When ingested, these substances act as hallucinogens, altering an individual's perceptions, thoughts, and feelings. Such drugs cause people to see or hear things that are not actually present.

53. (3) drinking water containing eggs of Ascaris
Ascaris lumbricoides is an intestinal roundworm that causes ascariasis in humans. The infection is primarily transmitted through the fecal-oral route. This occurs when individuals ingest food or drink water contaminated with the embryonated eggs of the parasite. Once inside the host, these eggs hatch in the intestine, and the larvae migrate through various organs before returning to the gut to mature.

54. (4) Lymphatic vessels of lower limbs
Wuchereria bancrofti is a parasitic filarial worm that causes lymphatic filariasis, commonly known as elephantiasis. These worms are typically found residing in the lymphatic vessels of the lower limbs in human hosts. Their presence causes chronic inflammation and physical blockage of lymph flow. Over several years, this leads to the massive swelling and deformity of the affected legs and other body parts.

55. (3) Lysergic acid diethylamide
Lysergic acid diethylamide, commonly known as LSD, is a powerful semi-synthetic drug categorized as a hallucinogen. It is derived from lysergic acid, which is found in the ergot fungus. LSD profoundly alters sensory perceptions, mood, and thought patterns, often causing vivid visual hallucinations. In contrast, caffeine is a stimulant, morphine is an analgesic, and opium is a natural source of various narcotics.

56. (1) gut of female Anopheles
In the life cycle of Plasmodium, fertilization of gametes occurs within the digestive tract of the female Anopheles mosquito. Following this, the resulting zygote transforms into a motile, elongated form known as an ookinete. This motile zygote then penetrates the wall of the mosquito's gut to develop into an oocyst on the outer surface. This stage is crucial for the parasite's development.

57. (4) typhoid fever.
The Widal test is a diagnostic serological test used to detect the presence of antibodies against Salmonella typhi, the bacterium responsible for typhoid fever. During the infection, the body produces specific agglutinins in response to the bacterial antigens. By observing the agglutination of bacterial suspensions when mixed with the patient's serum, clinicians can confirm a diagnosis of typhoid in suspected cases.

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110. (3) leukaemia
Leukaemia is a type of cancer that originates in the blood-forming tissues of the body, including the bone marrow and lymphatic system. It is characterized by the abnormal and uncontrolled production of white blood cells, which are often immature or dysfunctional. These malignant cells eventually crowd out healthy blood cells, leading to symptoms like fatigue, frequent infections, and easy bruising. It is distinct from conditions like haemophilia, which is a genetic bleeding disorder.

111. (4) acetylcholine.
Nicotine is a potent alkaloid found in tobacco that acts as a stimulant in the human body. Its physiological effects are primarily due to its ability to mimic the action of the neurotransmitter acetylcholine. Nicotine binds to specific nicotinic acetylcholine receptors in the nervous system, leading to the release of adrenaline and other signaling molecules. This increases heart rate, blood pressure, and alertness, while also contributing to the highly addictive nature of tobacco products.

112. (1) Syphilis-Treponema pallidum
Syphilis is a common sexually transmitted disease caused by the spirochete bacterium Treponema pallidum. This is a well-established medical fact. Other sexually transmitted diseases like gonorrhea are caused by Neisseria gonorrhoeae rather than Entamoeba histolytica, which is a protozoan causing intestinal issues. Urethritis can have many causes but is not typically associated with Bacillus anthracis. Accurate knowledge of these pathogens is vital for the effective clinical management and treatment of infections.

113. (4) on cell surface.
Antigens are substances that are recognized as foreign by the immune system and can trigger an immune response. They are typically found on the cell surface of pathogens like bacteria, viruses, and fungi. These surface molecules, which can be proteins or carbohydrates, serve as identifiable markers. By binding to these surface antigens, antibodies and immune cells can specifically target and destroy the invading organisms while sparing the body's own healthy cells.

114. (3) interferon
An interferon is a specialized, cell-coded protein produced by host cells when they are attacked by viruses. It is part of the body's innate immune defense. Once released, the interferon stimulates neighboring healthy cells to synthesize proteins that block viral replication. This provides a critical line of defense during the early stages of a viral infection. While antibodies are also proteins, they are part of the adaptive immune system and act through different mechanisms.

115. (1) fibroblasts
Sarcomas are malignant tumors that originate in connective or non-epithelial tissues of the body. This includes cells such as fibroblasts, which are the primary cells found in connective tissue. Sarcomas can develop in bones, cartilage, fat, and muscle. In contrast, carcinomas arise from epithelial cells. Understanding the tissue of origin is critical in oncology for determining the specific type of cancer, its potential for metastasis, and the most effective treatment strategies.

NODIA

116. (3) erythrocytes and liver cells
In the complex life cycle of the malarial parasite Plasmodium, asexual multiplication occurs within the human host through a process called schizogony. This process takes place in two primary locations. First, the parasites infect liver cells to undergo exo-erythrocytic schizogony. Subsequently, they enter the bloodstream to infect red blood cells, or erythrocytes, for erythrocytic schizogony. Both stages are essential for the expansion of the parasite population and the progression of the disease.

117. (4) Plasmodium.
The life cycle of the malarial parasite, Plasmodium, is dependent on the female Anopheles mosquito for transmission. These mosquitoes require stagnant water, such as that found in ponds and puddles, to lay their eggs and for their larvae to develop. If all such water bodies are destroyed, the mosquito population would decline sharply, breaking the transmission cycle. This environmental control strategy effectively reduces the prevalence of malaria by eliminating the necessary vector habitat.

118. (4) Wuchereria - Filariasis
Filariasis, also known as elephantiasis, is a parasitic disease caused by the filarial worm Wuchereria bancrofti. It is transmitted to humans

CHAPTER 27

Microbes in Human Welfare

2026 (RE-NEET)

1. Which of the following is used as a clot buster?
(1) Cyclosporin A
(2) Statins
(3) Streptokinase
(4) Penicillin

2026 (CANCELLED)

2. Match List I with List II:
List I (Bioactive molecules):
A. Streptokinase
B. Statins
C. Lipases
D. Cyclosporin A
List II (Importance):
I. Immunosuppressive agent
II. Removal of clots from the blood vessels
III. Blood cholesterol-lowering agent
IV. Detergent formulations
Choose the correct answer from the options given below :
(1) A-II, B-III, C-I, D-IV
(2) A-IV, B-III, C-II, D-I
(3) A-III, B-II, C-IV, D-I
(4) A-II, B-III, C-IV, D-I

2026 (CANCELLED)

3. What is the reason behind production of large holes in 'Swiss Cheese'?
(1) The production of large amount of CO_2 by Propionibacterium sharmanii
(2) The production of large amount of CO_2 by Clostridium butylicum
(3) The production of large amount of CO_2 and H_2 by lactic acid bacteria called Lactobacillus
(4) The production of large amount of CO_2 and H_2 by Trichoderma polysporum

2025

4. Which of the following microbes is not involved in the preparation of household products?
A. Aspergillus niger
B. Lactobacillus
C. Trichoderma polysporum
D. Saccharomyces cerevisiae
E. Propionibacterium sharmanii
Choose the correct answer from the options given below:
(1) C and D only
(2) C and E only
(3) A and B only
(4) A and C only

2025

5. Which of the following is an example of non-distilled alcoholic beverage produced by yeast?
(1) Beer
(2) Rum
(3) Whisky
(4) Brandy

2025

6. Streptokinase produced by bacterium Streptococcus is used for
(1) liver disease treatment
(2) removing clots from blood vessels
(3) curd production
(4) ethanol production.

2025

7. Which of following organisms cannot fix nitrogen?
A. Azotobacter
B. Oscillatoria
C. Anabaena
D. Volvox
E. Nostoc
Choose the correct answer from the options given below:
(1) B only (2) E only
(3) A only (4) D only

RE-EXAM 2024

8. Match List-I with List-II relating to microbes and their products.

	List-I (Microbes)		List-II (Products)
A.	Streptococcus	I.	Citric acid
B.	Trichoderma polysporum	II.	Clot buster
C.	Monascus purpureus	III.	Cyclosporin A
D.	Aspergillus niger	IV.	Statins

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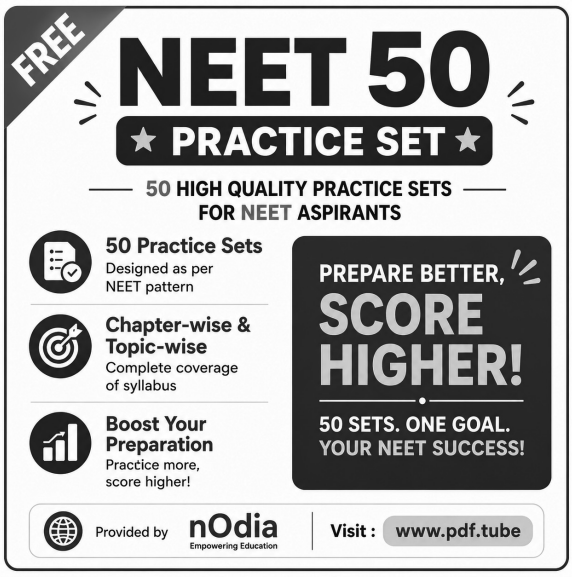
the parasite from reaching the central nervous system.

127. (3) merozoites
The clinical symptoms of malaria, particularly the recurring high fever and chills, are synchronized with a specific event in the parasite's life cycle. This occurs when a large number of infected red blood cells rupture simultaneously. This rupture releases a new generation of parasites called merozoites into the bloodstream, along with a toxic byproduct known as haemozoin. The sudden presence of these substances in the blood triggers the body's inflammatory response and fever.

128. (2) tse-tse fly
The tsetse fly is the primary vector responsible for the transmission of African sleeping sickness. These flies are found exclusively in sub-Saharan Africa. They acquire the Trypanosoma parasite by feeding on the blood of infected humans or animals and then pass it on to others during subsequent feedings. Controlling the population of tsetse flies through traps and environmental management is a critical component of public health efforts to eliminate this debilitating parasitic disease.

129. (4) T. gambiense.
African sleeping sickness is a parasitic infection caused by protozoans of the genus Trypanosoma. Specifically, Trypanosoma gambiense is the organism responsible for the chronic form of the disease found in West and Central Africa. It is transmitted to humans through the bite of the tsetse fly. The infection progresses slowly, eventually affecting the central nervous system and causing severe neurological symptoms. Another species, T. rhodesiense, causes an acute form of the disease in East Africa.



NODIA

(1) (A)-(iii); (B)-(iv); (C)-(ii); (D)-(i)
(2) (A)-(ii); (B)-(i); (C)-(iv); (D)-(iii)
(3) (A)-(i); (B)-(ii); (C)-(iv); (D)-(iii)
(4) (A)-(iv); (B)-(iii); (C)-(ii); (D)-(i)

2020

15. Which of the following is put into anaerobic sludge digester for further sewage treatment?
(1) Primary sludge
(2) Floating debris
(3) Effluents of primary treatment
(4) Activated sludge

2019

16. Which of the following is a commercial blood cholesterol lowering agent?
(1) Lipases
(2) Cyclosporin A
(3) Statin
(4) Streptokinase

2019

17. Which of the following is correctly matched for the product produced by them?
(1) Methanobacterium : Lactic acid
(2) Penicillium notatum : Acetic acid
(3) Sacchromyces cerevisiae : Ethanol
(4) Acetobacter aceti : Antibiotics

2019

18. Which of the following can be used as a biocontrol agent in the treatment of plant disease?
(1) Lactobacillus
(2) Trichoderma
(3) Chlorella
(4) Anabaena

2019

19. Select the correct group of biocontrol agents.
(1) Nostoc, Azospirillium, Nucleopolyhedrovirus
(2) Bacillus thuringiensis, Tobacco mosaic virus, Aphids
(3) Trichoderma, Baculovirus, Bacillus thuringiensis
(4) Oscillatoria, Rhizobium, Trichoderma

Odisha NEET 2019

20. A biocontrol agent to be a part of an integrated pest management should be
(1) species-specific and symbiotic
(2) free living and broad spectrum
(3) narrow spectrum and symbiotic
(4) species-specific and inactive on non-target organisms.

2018

21. Conversion of milk to curd improves its nutritional value by increasing the amount of
(1) vitamin D
(2) vitamin A
(3) vitamin B12
(4) vitamin E.

2017

22. Which of the following in sewage treatment removes suspended solids?
(1) Secondary treatment
(2) Primary treatment
(3) Sludge treatment
(4) Tertiary treatment

2017

23. Select the mismatch.
(1) Rhodospirillum - Mycorrhiza
(2) Anabaena - Nitrogen fixer
(3) Rhizobium - Alfalfa
(4) Frankia - Alnus

NEET-II 2016

24. Match column I with column II and select the correct option using the codes given below.

	Column I		Column II
A.	Citric acid	(i)	Trichoderma
B.	Cyclosporin A	(ii)	Clostridium
C.	Statins	(iii)	Aspergillus
D.	Butyric acid	(iv)	Monascus

(1) A-(iii), B-(i), C-(ii), D-(iv)
(2) A-(iii), B-(i), C-(iv), D-(ii)
(3) A-(i), B-(iv), C-(ii), D-(iii)
(4) A-(iii), B-(iv), C-(i), D-(ii)

NEET-I 2016

25. Which of the following is wrongly matched in the given table?

	Microbe	**Product**	**Application**
(1)	Streptococcus	Streptokinase	Removal of clot from blood vessel
(2)	Clostridium butylicum	Lipase	Removal of oil stains
(3)	Trichoderma polysporum	Cyclosporin A	Immuno-suppressive drug
(4)	Monascus purpureus	Statins	Lowering of blood cholesterol

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Choose the correct answer from the options given below.
(1) A-II, B-III, C-IV, D-I
(2) A-I, B-II, C-III, D-IV
(3) A-I, B-III, C-II, D-IV
(4) A-I, B-IV, C-II, D-III

RE-EXAM 2024

9. Given below are two statements.
Statement I : Antibiotics are chemicals produced by microbes that kill other microbes.
Statement II : Antibodies are chemicals formed in body that eliminate microbes.
In the light of the above statements, choose the most appropriate answer from the options given below.
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

2024

10. Match List I with List II.

	List-I		List-II
A.	Clostridium butylicum	I.	Ethanol
B.	Saccharomyces cerevisiae	II.	Streptokinase
C.	Trichoderma polysporum	III.	Butyric acid
D.	Streptococcus Sp.	IV.	Cyclosporin-A

Choose the correct answer from the options given below.
(1) A-III, B-I, C-II, D-IV
(2) A-II, B-IV, C-III, D-I
(3) A-III, B-I, C-IV, II
(4) A-IV, B-I, C-III, D-II

Manipur NEET 2023

11. Select the correct statements regarding dissolved oxygen and Biochemical Oxygen Demand.
(A) BOD is inversely related to dissolved oxygen.
(B) Low dissolved oxygen and high BOD lead to loss of aquatic life.
(C) High BOD leads to high dissolved oxygen.
(D) Both BOD and dissolved oxygen are indicator of health of a water body.
(E) Both BOD and dissolved oxygen are affected by amount of organic matter in the water body.
Choose the most appropriate answer from the options given below.
(1) (A), (B), (C), (E) only
(2) (A), (B), (D), (E) only
(3) (A), (B), (C), (D) only
(4) (B), (C), (D), (E) only

2022

12. Identify the microorganism which is responsible for the production of an immunosuppressive molecule cyclosporin A.
(1) Trichoderma polysporum
(2) Clostridium butylicum
(3) Aspergillus niger
(4) Streptococcus cerevisiae

NODIA

2021

13. Match List - I with List - II.

	List-I		List-II
(p)	Aspergillus niger	(i)	Acetic acid
(q)	Acetobacter aceti	(ii)	Lactic Acid
(r)	Clostridium butylicum	(iii)	Citric Acid
(s)	Lactobacillus	(iv)	Butyric Acid

Choose the correct answer from the option given below.
(1) (p)-(iv); (q)-(ii); (r)-(i); (s)-(iii)
(2) (p)-(iii); (q)-(i); (r)-(iv); (s)-(ii)
(3) (p)-(i); (q)-(ii); (r)-(iii); (s)-(iv)
(4) (p)-(ii); (q)-(iii); (r)-(i); (s)-(iv)

2020

14. Match the following columns and select the correct option.

	Column I		Column II
A.	Clostridium butylicum	(i)	Cyclosporin-A
B.	Trichoderma polysporum	(ii)	Butyric acid
C.	Monascus purpureus	(iii)	Citric acid
D.	Aspergillus niger	(iv)	Blood cholesterol lowering agent

(3) when treated in STPs does not really require the aeration step as the sewage contains adequate oxygen
(4) has very high amount of suspended solids and dissolved salts.

Mains 2012

36. In gobar gas, the maximum amount is that of
(1) butane
(2) methane
(3) propane
(4) carbon dioxide.

2012

37. Which one of the following is an example of carrying out biological control of pests/diseases using microbes?
(1) Trichoderma sp. against certain plant pathogens.
(2) Nucleopolyhedrovirus against white rust in Brassica.
(3) Bt-cotton to increase cotton yield.
(4) Lady bird beetle against aphids in mustard.

2012

38. A nitrogen-fixing microbe associated with Azolla in rice fields is
(1) Spirulina
(2) Anabaena
(3) Frankia
(4) Tolypothrix.

2012

39. Which one of the following microbes forms symbiotic association with plants and helps them in their nutrition?
(1) Azotobacter
(2) Aspergillus
(3) Glomus
(4) Trichoderma

2011

40. The most common substrate used in distilleries for the production of ethanol is
(1) corn meal
(2) soya meal
(3) ground gram
(4) molasses.

2011

41. Ethanol is commercially produced through a particular species of
(1) Saccharomyces
(2) Clostridium
(3) Trichoderma
(4) Aspergillus.

2011

42. Continuous addition of sugars in 'fed batch' fermentation is done to
(1) produce methane
(2) obtain antibiotics
(3) purify enzymes
(4) degrade sewage.

Mains 2011

43. Read the following statement having two blanks (A and B).
A drug used for _A_ patients is obtained from a species of the organism _B_ .
The one correct option for the two blanks is

	A	**B**
(1)	Heart	Penicillium
(2)	Organ-transplant	Trichoderma
(3)	swine flu	Monascus
(4)	AIDS	Pseudomonas

Mains 2011

44. Which one of the following is a wrong matching of a microbe and its industrial product, while the remaining three are correct?
(1) Yeast - Statins
(2) Acetobacter aceti - Acetic acid
(3) Clostridium butylicum - Lactic acid
(4) Aspergillus niger - Citric acid

2011

45. Secondary sewage treatment is mainly a
(1) physical process
(2) mechanical process
(3) chemical process
(4) biological process.

2011

46. Which of the following is mainly produced by the activity of anaerobic bacteria on sewage?
(1) Laughing gas (2) propane
(3) Mustard gas (4) Marsh gas

2011

47. Organisms called methanogens are most abundant in a
(1) sulphur rock
(2) cattle yard
(3) polluted stream
(4) hot spring.

2011

48. A prokaryotic autotrophic nitrogen fixing symbiont is found in
(1) Alnus (2) Cycas
(3) Cicer (4) Pisum.

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2015

26. Match the following organisms with the products they produce.

	Column I (Organisms)		Column II (Products)
A.	Lactobacillus	(i)	Cheese
B.	Saccharomyces cerevisiae	(ii)	Curd
C.	Aspergillus niger	(iii)	Citric acid
D.	Acetobacter aceti	(iv)	Bread
		(v)	Acetic acid

Select the correct option.
(1) (A)-(ii); (B)-(i); (C)-(iii); (D)-(v)
(2) (A)-(ii); (B)-(iv); (C)-(v); (D)-(iii)
(3) (A)-(ii); (B)-(iv); (C)-(iii); (D)-(v)
(4) (A)-(iii); (B)-(iv); (C)-(v); (D)-(i)

2015

27. Match the following list of microbes and their importance.

	Column I		Column II
A.	Saccharomyces cerevisiae	(i)	Production of immuno-suppressive agent
B.	Monascus purpureus	(ii)	Ripening of Swiss cheese
C.	Trichoderma polysporum	(iii)	Commercial production of ethanol
D.	Propionibacte-rium shermanii	(iv)	Production of blood-cholesterol lowering agents

(1) A-(iv), B-(ii), C-(i), D-(iii)
(2) A-(iii), B-(i), C-(iv), D-(ii)
(3) A-(iii), B-(iv), C-(i), D-(ii)
(4) A-(iv), B-(iii), C-(ii), D-(i)

2015 Cancelled

28. The guts of cow and buffalo possess
(1) methanogens (2) cyanobacteria
(3) Fucus sp. (4) Chlorella sp.

2014

29. What gases are produced in anaerobic sludge digesters?
(1) Methane and CO_2 only
(2) Methane, Hydrogen sulphide and CO_2
(3) Methane, Hydrogen sulphide and O_2
(4) Hydrogen sulphide and CO_2

2013

30. A good producer of citric acid is
(1) Clostridium
(2) Saccharomyces
(3) Aspergillus
(4) Pseudomonas.

Karnataka NEET 2013

31. Microbe used for biocontrol of pest butterfly caterpillars is
(1) Saccharomyces cerevisiae
(2) Bacillus thuringiensis
(3) Streptococcus sp.
(4) Trichoderma sp.

2012

32. Monascus purpureus is a yeast used commercially in the production of
(1) ethanol
(2) streptokinase for removing clots from the blood vessels
(3) citric acid
(4) blood cholesterol lowering statins.

2012

33. A patient brought to a hospital with myocardial infarction is normally immediately given
(1) penicillin
(2) streptokinase
(3) cyclosporin-A
(4) statins.

Mains 2012

34. Read the following four statements (A-D).
(A) Colostrum is recommended for the new born because it is rich in antigens.
(B) Chikungunya is caused by a Gram negative bacterium.
(C) Tissue culture has proved useful in obtaining virus-free plants.
(D) Beer is manufactured by distillation of fermented grape juice.
How many of the above statements are wrong?
(1) Two
(2) Three
(3) Four
(4) One

Mains 2012

35. The domestic sewage in large cities
(1) has a high BOD as it contains both aerobic and anaerobic bacteria
(2) is processed by aerobic and then anaerobic bacteria in the secondary treatment in Sewage Treatment Plants (STPs)

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through the bites of infected mosquitoes. The worms reside in the lymphatic system, causing chronic inflammation and swelling. The other options are incorrect because Anopheles is a vector, not a germ; Leishmania causes kala-azar rather than sleeping sickness; and Glossina is the vector for sleeping sickness rather than being the pathogen itself.

119. (3) heroin
Heroin is a semi-synthetic drug derived from morphine and is classified as an opiate narcotic. It acts as a powerful central nervous system depressant, significantly slowing down physiological functions and providing intense pain relief. While morphine is a natural opiate, heroin is more potent due to its chemical modifications. In contrast, bhang and charas are preparations from the cannabis plant, and nicotine is a stimulant found in tobacco that mimics neurotransmitters.

120. (1) sexual cycle
The life cycle of Plasmodium vivax is split between two hosts. The asexual cycle occurs within the human host, involving stages like pre-erythrocytic and erythrocytic schizogony. The sexual cycle, which includes gamete fusion and the formation of a zygote, takes place within the female Anopheles mosquito. This mosquito serves as the definitive host where the parasite undergoes genetic recombination before producing the infectious sporozoites that can then be transmitted back to humans.

121. (3) Trypanosoma gambiense transmitted by Glossina palpalis
African sleeping sickness, also known as human African trypanosomiasis, is a parasitic disease caused by the protozoan Trypanosoma gambiense. It is primarily transmitted to humans through the bite of an infected tsetse fly, specifically the species Glossina palpalis. The parasite eventually invades the central nervous system, leading to the characteristic lethargy and sleep disturbances. Proper control of the tsetse fly population is a key strategy for preventing the spread of this serious disease.

122. (1) Plasmodium falciparum
Malaria is caused by several species of the protozoan genus Plasmodium. Among these, Plasmodium falciparum is responsible for the most severe and dangerous form of the disease, known as malignant tertian malaria. This species is characterized by its high mortality rate if left untreated, as it can cause complications like cerebral malaria. Other species like P. vivax, P. ovale, and P. malariae generally cause milder, though still significant, forms of the infection.

123. (3) Laveran
Charles Louis Alphonse Laveran was a French army physician who made a groundbreaking discovery in eighteen eighty. While working in Algeria, he observed the malarial parasite, Plasmodium, within the red blood cells of an infected patient. This observation proved that malaria was caused by a protozoan parasite rather than by bad air or miasma. For this foundational work in parasitology, Laveran was awarded the Nobel Prize in Physiology or Medicine in nineteen hundred and seven.

124. (2) sporozoite
In the transmission of malaria, the sporozoite is the specific stage of the Plasmodium parasite that is infectious to humans. These sporozoites develop within the mosquito and migrate to its salivary glands. When a female Anopheles mosquito bites a human to feed on blood, it injects these sporozoites into the bloodstream. From there, the parasites travel to the liver to begin the next phase of their complex life cycle within the host.

NODIA

125. (2) relieve pain
Analgesics are a class of medications specifically designed to achieve the relief of physical pain. They work by acting on the peripheral or central nervous systems to block pain signals or alter the brain's perception of pain. Common examples include aspirin, paracetamol, and more potent opioid drugs like morphine. Unlike sedatives, they do not always induce sleep, and unlike stimulants, they do not increase alertness; their primary clinical purpose is pain management.

126. (2) Trypanosoma gambiense
The tsetse fly, belonging to the genus Glossina, serves as the biological vector for the protozoan parasite Trypanosoma gambiense. When an infected tsetse fly bites a human, it transmits the parasite into the bloodstream, which can eventually lead to African sleeping sickness. This disease is localized to certain regions of sub-Saharan Africa where the vector thrives. Early diagnosis and treatment are essential to prevent

2011

49. Which one of the following helps in absorption of phosphorus from soil by plants?
(1) Glomus (2) Rhizobium
(3) Frankia (4) Anabaena

2011

50. Which one of the following is not a biofertiliser?
(1) Agrobacterium
(2) Rhizobium
(3) Nostoc
(4) Mycorrhiza

2011

51. An organism used as a biofertilizer for raising soybean crop is
(1) Azotobacter
(2) Azospirillum
(3) Rhizobium
(4) Nostoc.

Mains 2011

52. Consider the following statements (A-D) about organic farming.
(A) Utilizes genetically modified crops like Bt cotton
(B) Uses only naturally produced inputs like compost
(C) Does not use pesticides and urea
(D) Produces vegetables rich in vitamins and minerals
Which of the above statements are correct?
(1) B, C and D
(2) C and D only
(3) B and C only
(4) A and B only

2010

53. Select the correct statement from the following.
(1) Biogas is produced by the activity of aerobic bacteria on animal waste.
(2) Methanobacterium is an aerobic bacterium found in rumen of cattle.
(3) Biogas, commonly called gobar gas, is pure methane.
(4) Activated sludge-sediment in settlement tanks of sewage treatment plant is a rich source of aerobic bacteria.

2010

54. A common biocontrol agent for the control of plant diseases is
(1) baculovirus
(2) Bacillus thuringiensis
(3) Glomus
(4) Trichoderma.

2010

55. The common nitrogen-fixer in paddy fields is
(1) Rhizobium
(2) Azospirillum
(3) Oscillatoria
(4) Frankia.

2010

56. Which one of the following is not used in organic farming?
(1) Glomus
(2) Earthworm
(3) Oscillatoria
(4) Snail

Mains 2010

57. An example of endomycorrhiza is
(1) Nostoc
(2) Glomus
(3) Agaricus
(4) Rhizobium.

2009

58. Which one of the following pairs is wrongly matched?
(1) Alcohol - Nitrogenase
(2) Fruit juice - Pectinase
(3) Textile - Amylase
(4) Detergents - Lipase

2009

59. Which of the following is not used as a biopesticide?
(1) Trichoderma harzianum
(2) Nucleopolyhedrovirus (NPV)
(3) Xanthomonas campestris
(4) Bacillus thuringiensis

2008

60. Trichoderma harzianum has proved a useful microorganism for
(1) gene transfer in higher plants
(2) biological control of soil-borne plant pathogens
(3) bioremediation of contaminated soils
(4) reclamation of wastelands.

2008

61. Which one of the following proved effective for biological control of nematodal diseases in plants?
(1) Gliocladium virens
(2) Paecilomyces lilacinus
(3) Pisolithus tinctorius
(4) Pseudomonas cepacia

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2008

62. Nitrogen fixation in root nodules of Alnus is brought about by
(1) Frankia
(2) Azorhizobium
(3) Bradyrhizobium
(4) Clostridium.

2007

63. Probiotics are
(1) cancer inducing microbes
(2) new kind of food allergens
(3) live microbial food supplement
(4) safe antibiotics.

2007

64. Which one of the following pairs is wrongly matched?
(1) Yeast - Ethanol
(2) Streptomycetes - Antibiotic
(3) Coliforms - Vinegar
(4) Methanogens - Gobar gas

2007

65. A genetically engineered microorganism used successfully in bioremediation of oil spills is a species of
(1) Trichoderma
(2) Xanthomonas
(3) Bacillus
(4) Pseudomonas.

2004

66. Dough kept overnight in warm weather becomes soft and spongy because of
(1) absorption of carbon dioxide from atmosphere
(2) fermentation
(3) cohesion
(4) osmosis.

2004

67. A major component of gobar gas is
(1) ammonia
(2) methane
(3) ethane
(4) butane.

2004

68. Which one of the following pairs is not correctly matched?
(1) Streptomyces - Antibiotic
(2) Serratia - Drug addiction
(3) Spirulina - Single cell protein
(4) Rhizobium - Biofertilizer

NODIA

2004

69. A free living nitrogen-fixing cyanobacterium which can also form symbiotic association with the water fern Azolla is
(1) Tolypothrix
(2) Chlorella
(3) Nostoc
(4) Anabaena.

2003

70. During anaerobic digestion of organic waste, such as in producing biogas, which one of the following is left undegraded ?
(1) Lipids
(2) Lignin
(3) Hemi-cellulose
(4) Cellulose

2003

71. Which one of the following plants are used as green manure in crop fields and in sandy soils?
(1) Crotalaria juncea and Alhagi camelorum
(2) Calotropis procera and Phyllanthus niruri
(3) Saccharum munja and Lantana camara
(4) Dichanthium annulatum and Azolla nilotica

2002

72. During the formation of bread it becomes porous due to release of CO_2 by the action of
(1) yeast
(2) bacteria
(3) virus
(4) protozoans.

2002

73. Which bacteria is utilized in gobar gas plant?
(1) Methanogens
(2) Nitrifying bacteria
(3) Ammonifying bacteria
(4) Denitrifying bacteria

2001

74. Which of the following is the pair of biofertilizers?
(1) Azolla and BGA
(2) Nostoc and legume
(3) Rhizobium and grasses
(4) Salmonella and E.coli

2000

75. Which of the following is used to manufacture ethanol from starch?
(1) Penicillium
(2) Saccharomyces
(3) Azotobacter
(4) Lactobacillus

2000

76. Which aquatic fern is used to increase the yield in paddy crop?
(1) Azolla
(2) Salvinia
(3) Marsilea
(4) Isoetes

1999

77. Which of the following fern is an excellent biofertilizer?
(1) Marsilea
(2) Pteridium
(3) Azolla
(4) Salvinia

1999

78. Due to which of the following organism, yield of rice is increased?
(1) Sesbania
(2) Bacillus popilliae
(3) Anabaena
(4) Bacillus subtilis

1998

79. Yeast (Saccharomyces cerevisiae) is used in the industrial production of
(1) tetracyline
(2) ethanol
(3) butanol
(4) citric acid.

1998

80. Which of the following microorganisms is used for production of citric acid in industries?
(1) Aspergillus niger
(2) Rhizopus nigricans
(3) Lactobacillus bulgaris
(4) Penicillium citrinum

1998

81. Biological control component is central to advanced agricultural production. Which of the following is used as a third generation pesticide?
(1) Insect repellants
(2) Organophosphate and carbamates
(3) Pathogens
(4) Pheromones

1998

82. Which of the following is non-symbiotic biofertilizer?
(1) Anabaena
(2) Rhizobium
(3) VAM
(4) Azotobacter

1998

83. Farmers have reported over 50% higher yields of rice by using which of the following biofertilizer?
(1) Cyanobacteria
(2) Legume-Rhizobium symbiosis
(3) Mycorrhiza
(4) Azolla pinnata

1997

84. Gobar gas contains mainly
(1) $CO_2 + H_2$ (2) $CO_2 + H_2O$
(3) CH_4 only (4) $CH_4 + CO_2$.

1997

85. The biofertilizers are
(1) Anabaena and Azolla
(2) cow dung, manure and farmyard waste
(3) quick growing crop ploughed under soil
(4) none of these.

1996

86. Which of the following is the false statement about antibiotics?
(1) Some persons have allergy from antibiotics.
(2) Antibiotics are capable of curing any disease.
(3) This term was given by Waksman in 1942.
(4) Antibiotics is produced by microorganisms.

1996

87. Cochineal insects have proved very useful for
(1) cactus prevention
(2) Eichhornia prevention
(3) weeds control
(4) Parthenium control.

1996

88. When a natural predator (living being) is applied on the other pathogen organism to control them, this process is called
(1) artificial control
(2) confusion technique
(3) biological control
(4) genetic engineering.

1995

89. The citric acid is produced by
(1) Candida utilis
(2) Azotobacter suboxydans
(3) Aspergillus niger
(4) Streptococcus lactis.

1995

90. The organism, used for alcohol fermentation, is
(1) Aspergillus
(2) Saccharomyces
(3) Pseudomonas
(4) Penicillium.

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Trichoderma polysporum is the biological source of the immunosuppressive agent cyclosporin A. Propionibacterium shermanii is responsible for the large holes in Swiss cheese due to the production of high amounts of carbon dioxide.

28. (1) methanogens
The digestive tract of ruminants, such as cows and buffaloes, contains a specialized stomach compartment called the rumen. This environment is inhabited by methanogens, specifically Methanobacterium. These anaerobic bacteria help in the breakdown of cellulose, which is a major component of the cattle's plant-based diet. A significant byproduct of this microbial fermentation is the production of methane gas, commonly called biogas.

29. (2) Methane, Hydrogen sulphide and CO_2
In sewage treatment plants, anaerobic sludge digesters utilize anaerobic bacteria to decompose the organic matter and microbial flocs present in the sludge. During this digestion process, the bacteria produce a mixture of gases known as biogas. This mixture primarily consists of methane, which is flammable, along with carbon dioxide and hydrogen sulphide. This gas can be used as an energy source.

30. (3) Aspergillus
Citric acid is a widely used organic acid in the food, pharmaceutical, and cosmetic industries. While several microorganisms can produce it, the fungus Aspergillus niger is the most efficient and commonly used producer for large-scale industrial manufacture. Through controlled fermentation of carbohydrate-rich substrates, this microbe converts sugars into citric acid. This process is favored due to high yields and relatively simple purification steps.

31. (2) Bacillus thuringiensis
Bacillus thuringiensis is a bacterium used as a highly effective biocontrol agent against insect pests, particularly butterfly caterpillars. It produces a specific toxin protein that, when ingested by the larvae, becomes active in their alkaline gut environment. This toxin creates pores in the gut wall, leading to the death of the pest. It is a preferred method in sustainable agriculture.

32. (4) blood cholesterol lowering statins.
Monascus purpureus is a species of yeast used for the commercial production of statins. Statins are bioactive molecules that serve as blood cholesterol-lowering agents. They work by competitively inhibiting the enzyme HMG-CoA reductase, which is essential for the internal synthesis of cholesterol in the human body. This microbial product is an important pharmacological tool for managing hypercholesterolemia and associated cardiovascular diseases.

33. (2) streptokinase
Myocardial infarction, commonly known as a heart attack, often occurs due to the formation of blood clots in the coronary arteries. Patients brought to the hospital with this condition are immediately treated with streptokinase. This enzyme, produced by the bacterium Streptococcus and modified by biotechnology, acts as a "clot buster." It effectively dissolves the fibrin clots, restoring blood flow to the heart.

34. (2) Three
Several biological statements require careful evaluation. Colostrum is rich in antibodies, specifically IgA, not antigens. Chikungunya is a viral disease, not bacterial. Beer is a non-distilled alcoholic beverage, unlike distilled spirits. However, tissue culture is indeed a valid method for producing virus-free plants from infected ones using meristem culture. Therefore, three of the given statements contain factual errors regarding immunology and microbiology.

35. (2) is processed by aerobic and then anaerobic bacteria in the secondary treatment in Sewage Treatment Plants (STPs)
Large-scale domestic sewage treatment in cities involves multiple biological steps. In Sewage Treatment Plants, the secondary treatment phase utilizes aerobic bacteria in aeration tanks to reduce the Biochemical Oxygen Demand by consuming organic matter. Following this, the remaining sludge is processed by anaerobic bacteria in anaerobic sludge digesters. This sequential use of different microbial groups ensures the effective purification of wastewater before disposal.

36. (2) methane
Gobar gas, or biogas, is produced through the anaerobic fermentation of animal dung and organic waste by methanogenic bacteria.

NODIA

ANSWERS

1. (3) Streptokinase
Streptokinase, produced by Streptococcus bacteria and modified by genetic engineering, is used as a clot buster (thrombolytic agent). It dissolves blood clots in the vessels of patients who have had a heart attack.

2. (4) A-II, B-III, C-IV, D-I
Streptokinase removes clots from blood vessels (clot buster). Statins act as blood cholesterol-lowering agents. Lipases are used in detergent formulations to remove oily stains. Cyclosporin A is an immunosuppressive agent used in organ transplantation. This gives the match A-II, B-III, C-IV, D-I.

3. (1) The production of large amount of CO_2 by Propionibacterium sharmanii
The large holes in Swiss cheese are produced by the bacterium Propionibacterium sharmanii, which releases a large amount of carbon dioxide during fermentation. The trapped CO_2 gas forms cavities or holes in the cheese, giving Swiss cheese its characteristic appearance.

4. (4) A and C only
Household products like curd, dough, and toddy involve specific microorganisms. Lactobacillus is essential for curd formation from milk, while Saccharomyces cerevisiae, known as baker's yeast, is used for making bread. Propionibacterium shermanii provides the characteristic texture of Swiss cheese. Conversely, Aspergillus niger is used for industrial citric acid production, and Trichoderma polysporum produces medical immunosuppressants.

5. (1) Beer
Alcoholic beverages are produced through the fermentation of malted cereals or fruit juices by yeast strains. Depending on the processing method, these beverages are categorized as distilled or non-distilled. Beverages like wine and beer are produced without the distillation process, preserving specific flavors. In contrast, whisky, brandy, and rum require distillation of the fermented broth to increase alcohol concentration.

6. (2) removing clots from blood vessels
Streptokinase is a functional enzyme produced by the bacterium Streptococcus and later modified through genetic engineering. It serves as a potent clot buster in medical treatments. This enzyme is administered to patients who have undergone myocardial infarction to dissolve fibrin clots within blood vessels. Such clinical applications are vital for restoring blood flow and preventing further damage to heart tissues.

7. (4) D only
Nitrogen fixation is a biological process where atmospheric nitrogen is converted into ammonia by specific prokaryotes. Organisms like Azotobacter, Anabaena, Nostoc, and Oscillatoria possess the necessary nitrogenase enzymes to perform this task in various ecosystems. However, Volvox is a colonial green alga that lacks the physiological machinery for nitrogen fixation. It primarily functions as a photosynthetic autotroph in freshwater habitats.

8. (1) A-II, B-III, C-IV, D-I
Various microorganisms are utilized industrially for their specific metabolic products. Streptococcus produces streptokinase, which acts as a clot buster. Trichoderma polysporum is the source of cyclosporin A, used as an immunosuppressive agent. Monascus purpureus produces statins to lower blood cholesterol levels. Aspergillus niger is a fungal species used for the large-scale commercial production of citric acid in the industry.

9. (3) Both statement I and statement II are correct.
Microorganisms and the human immune system produce specific chemical substances to combat pathogens. Antibiotics are chemical substances produced by certain microbes, like fungi or bacteria, that can kill or inhibit the growth of other harmful microorganisms. Similarly, antibodies are specialized proteins formed within the human body by B-lymphocytes. These molecules recognize and eliminate invading foreign microbes, providing essential biological immunity.

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64. (3) Coliforms - Vinegar
Microbial matches depend on the specific metabolic capabilities of the organisms. Yeast is used for ethanol, Streptomycetes produce various antibiotics, and methanogens are essential for gobar gas production. However, coliforms are a group of bacteria used as indicators of water pollution and fecal contamination. They are not used in vinegar production; vinegar is produced by the aerobic fermentation of ethanol by Acetobacter aceti.

65. (4) Pseudomonas.
Bioremediation is the use of microorganisms to clean up environmental pollutants. A prominent example is the use of a genetically engineered species of Pseudomonas, specifically Pseudomonas putida, known as the "superbug." This bacterium was developed to possess multiple plasmids that allow it to degrade different components of crude oil. It has been successfully used to treat and mitigate the environmental impact of oil spills.

66. (2) fermentation
When dough is kept overnight in warm weather, it undergoes the process of fermentation by yeast and other naturally occurring microorganisms. During this metabolic process, sugars in the dough are converted into ethanol and carbon dioxide gas. The release and entrapment of carbon dioxide bubbles cause the dough to rise and become soft and spongy. This transformation is fundamental to traditional bread and snack making.

67. (2) methane
Gobar gas, produced in biogas plants from animal dung, is a renewable energy source generated through anaerobic digestion. The most significant and abundant component of this gas is methane, which usually accounts for more than half of its composition. Methane is highly flammable, making the gas suitable for cooking and lighting. Other minor components include carbon dioxide, hydrogen, and hydrogen sulphide.

68. (2) Serratia - Drug addiction
Various microorganisms have established roles in industry and biotechnology. Streptomyces is a well-known source of antibiotics, Spirulina is harvested as a high-protein single-cell protein, and Rhizobium acts as a vital biofertilizer. However, Serratia is a genus of bacteria that does not have any known connection to drug addiction. Serratia marcescens is often studied as an opportunistic pathogen and for its red pigmentation.

69. (4) Anabaena.
Anabaena is a genus of filamentous cyanobacteria known for its ability to fix atmospheric nitrogen. It exists in both free-living forms and in symbiotic associations. One of its most significant relationships is with the aquatic water fern Azolla. The cyanobacterium resides in the leaf cavities of the fern, providing fixed nitrogen in exchange for a protected habitat. This association is widely used as a biofertilizer.

70. (2) Lignin
During the anaerobic digestion of organic waste in a biogas plant, complex organic molecules are broken down by various groups of bacteria. While substances like lipids, cellulose, and hemicellulose are eventually degraded into simpler molecules and then into biogas, lignin remains largely undegraded. Lignin is a highly complex, recalcitrant polymer found in plant cell walls that is resistant to most anaerobic microbial enzymes.

71. (1) Crotalaria juncea and Alhagi camelorum
Green manure involves growing specific crops and plowing them back into the soil to improve fertility and structure. Crotalaria juncea, commonly known as sunn hemp, and Alhagi camelorum are frequently used for this purpose, especially in sandy soils. These plants are often leguminous, meaning they fix atmospheric nitrogen, which then enriches the soil as the plant matter decomposes after being incorporated.

72. (1) yeast
The production of bread relies on the metabolic activity of Saccharomyces cerevisiae, commonly known as baker's yeast. During the fermentation of the dough, the yeast cells consume sugars and release carbon dioxide gas as a byproduct. As the dough is baked, the escaping gas creates numerous small pores, giving the bread its characteristic light and airy texture. This process is essential for modern baking.

73. (1) Methanogens
In a gobar gas plant, animal waste is processed under anaerobic conditions to produce biogas.

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19. (3) Trichoderma, Baculovirus, Bacillus thuringiensis
Biocontrol agents are living organisms used to manage pest populations and plant diseases naturally. Trichoderma is a fungus effective against many soil-borne pathogens. Baculoviruses, specifically Nucleopolyhedrovirus, are pathogens that attack insects and other arthropods with high species specificity. Bacillus thuringiensis is a bacterium used to control butterfly caterpillars. Together, these organisms form a sustainable strategy for integrated pest management in agriculture.

20. (4) species-specific and inactive on non-target organisms.
Integrated Pest Management requires biocontrol agents that are highly specific in their action. A desirable agent should target only the intended pest species while remaining inactive on non-target organisms, such as beneficial insects, birds, and mammals. This specificity ensures that the ecological balance is maintained and that biodiversity is protected while effectively reducing the population of harmful pests in agricultural fields.

21. (3) vitamin B12
The conversion of milk to curd is facilitated by Lactic Acid Bacteria, such as Lactobacillus. During this fermentation process, these bacteria produce acids that coagulate and partially digest the milk proteins. This biological transformation not only changes the texture and taste of the milk but also significantly enhances its nutritional value by increasing the concentration of vitamin B12 and other nutrients.

22. (2) Primary treatment
Sewage treatment involves multiple stages to remove pollutants from wastewater. Primary treatment is a physical process that focuses on the removal of large and small particles through sequential filtration and sedimentation. Suspended solids and floating debris are separated to form primary sludge and effluent. This stage is essential before the effluent undergoes biological secondary treatment involving aerobic and anaerobic microorganisms for further purification.

23. (1) Rhodospirillum - Mycorrhiza
Microorganisms form various ecological relationships with plants. Anabaena is a nitrogen-fixing cyanobacterium. Rhizobium forms symbiotic nodules on legume roots like Alfalfa. Frankia is an actinomycete that fixes nitrogen in non-leguminous plants like Alnus. However, Rhodospirillum is a free-living, anaerobic nitrogen-fixing bacterium and does not form mycorrhizal associations. Mycorrhiza is a symbiotic relationship between fungi, such as Glomus, and plant roots.

24. (2) A-(iii), B-(i), C-(iv), D-(ii)
Microbes are utilized for the production of various organic chemicals and bioactive molecules. Aspergillus niger is the source of citric acid. Trichoderma polysporum produces cyclosporin A, which is used to prevent organ transplant rejection. Monascus purpureus is the yeast responsible for producing blood cholesterol-lowering statins. Clostridium butylicum is a bacterium used industrially to synthesize butyric acid through specialized fermentation processes.

25. (2) Clostridium butylicum - Lipase - Removal of oil stains
Microbes provide various enzymes and bioactive molecules for industrial and medical use. Streptokinase from Streptococcus acts as a clot buster. Cyclosporin A from Trichoderma polysporum is an immunosuppressant. Statins from Monascus purpureus lower cholesterol. However, Clostridium butylicum produces butyric acid, not lipase. Lipases, used for removing oil stains in detergents, are typically obtained from fungi like Candida or other specialized microbial sources.

NODIA

26. (3) (ii) (iv) (iii) (v)
Diverse microorganisms are employed in the production of food items and industrial chemicals. Lactobacillus is vital for converting milk into curd. Saccharomyces cerevisiae, or baker's yeast, is used in bread making to provide a porous texture. Aspergillus niger is a fungus utilized for the commercial production of citric acid. Acetobacter aceti is a bacterium that performs the aerobic fermentation of ethanol to acetic acid.

27. (3) A-(iii), B-(iv), C-(i), D-(ii)
Microbes play significant roles in industrial and medical applications. Saccharomyces cerevisiae is essential for the commercial production of ethanol. Monascus purpureus yields statins, which are utilized as blood-cholesterol lowering agents.

present in the effluent. This microbial activity significantly reduces the biochemical oxygen demand of the water, making it cleaner before discharge or further treatment.

46. (4) Marsh gas
During the anaerobic digestion of sewage sludge, specific groups of bacteria work under oxygen-free conditions to break down organic matter. This microbial activity produces a mixture of gases known as biogas. The primary gas produced is methane, also referred to as marsh gas because it is commonly found in wetlands and marshes. This gas is combustible and serves as a valuable renewable energy source.

47. (2) cattle yard
Methanogens are specialized anaerobic bacteria that produce methane gas as a metabolic byproduct. These organisms are most abundant in environments like the rumen of cattle and in cattle yards where dung is collected. They play a vital role in the breakdown of cellulose in the digestive systems of ruminants. Consequently, animal waste in cattle yards provides an ideal anaerobic, nutrient-rich habitat.

48. (2) Cycas
Symbiotic nitrogen fixation occurs in various plant groups. In the gymnosperm Cycas, specialized roots called coralloid roots harbor nitrogen-fixing cyanobacteria like Anabaena. These prokaryotic autotrophs fix atmospheric nitrogen into a form that the plant can utilize for growth. This symbiotic association is crucial for the survival of Cycas in nutrient-poor soils, as it provides a steady source of essential nitrogen.

49. (1) Glomus
Mycorrhizal associations are symbiotic relationships between fungi and the roots of higher plants. Fungi belonging to the genus Glomus are known for their ability to form these associations. The fungal hyphae extend into the soil, significantly increasing the surface area for nutrient absorption. They are particularly effective at absorbing phosphorus, which is often a limiting nutrient, and transferring it to the host plant.

50. (1) Agrobacterium
Biofertilisers are living organisms that enrich the nutrient quality of the soil, such as Rhizobium, Nostoc, and Mycorrhizal fungi. These organisms fix nitrogen or enhance mineral absorption. However, Agrobacterium is not a biofertilizer; it is a genus of bacteria known primarily as plant pathogens. It is widely used in biotechnology as a vector for gene transfer rather than for enhancing soil fertility.

51. (3) Rhizobium
Soybean is a leguminous crop that requires significant amounts of nitrogen for protein synthesis. To meet this requirement naturally, farmers use the bacterium Rhizobium as a biofertilizer. Rhizobium forms a symbiotic association with the roots of the soybean plant, creating nodules where it fixes atmospheric nitrogen into ammonia. This biological nitrogen fixation provides an essential nutrient source, reducing the need for chemicals.

52. (3) B and C only
Organic farming is a sustainable agricultural system that emphasizes ecological balance. It relies on the use of naturally produced inputs like compost and green manure instead of synthetic chemical fertilizers like urea. Furthermore, organic farming avoids the use of chemical pesticides and genetically modified organisms, such as Bt cotton. The goal is to produce healthy food while maintaining soil fertility and minimizing environmental pollution.

53. (4) Activated sludge-sediment in settlement tanks of sewage treatment plant is a rich source of aerobic bacteria.
In the process of sewage treatment, the effluent from the primary settling tank is passed into large aeration tanks. Here, aerobic microbes grow into flocs, consuming organic matter. When the BOD is reduced, the effluent is passed to a settling tank where the bacterial flocs sediment. This sediment is called activated sludge and is a concentrated source of active aerobic microorganisms.

54. (4) Trichoderma.
Biological control uses natural enemies to manage pests and diseases. Trichoderma is a common free-living fungus found in soil and root ecosystems. It is widely recognized as a versatile biocontrol agent for managing various soil-borne plant pathogens. Trichoderma works through mechanisms like mycoparasitism and competition, providing a sustainable and environmentally safe alternative to chemical fungicides in modern agricultural practices.

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The chemical composition of this gas consists of a mixture of gases, where methane is the predominant component, typically making up 50% to 70% of the total volume. Other components include carbon dioxide and small amounts of hydrogen sulphide and hydrogen.

37. (1) Trichoderma sp. against certain plant pathogens.
Biological control involves using microorganisms to manage pests and diseases without chemical intervention. Trichoderma species are free-living fungi found in soil and root environments that act as effective biocontrol agents against various plant pathogens. While other methods like using ladybird beetles or Bt-cotton exist, the use of Trichoderma specifically represents a microbial strategy for protecting plant health in sustainable agriculture.

38. (2) Anabaena
Rice cultivation in paddy fields is often enhanced by the use of biofertilizers. Anabaena azollae is a nitrogen-fixing cyanobacterium that maintains a symbiotic relationship with the aquatic fern Azolla. This association allows for the fixation of atmospheric nitrogen, which becomes available to the rice plants, thereby improving soil fertility and increasing crop yield. It is an eco-friendly alternative to chemical fertilizers.

39. (3) Glomus
Many plants form symbiotic associations with fungi to enhance their nutrient uptake. Fungi of the genus Glomus form mycorrhizal associations with the roots of higher plants. In this relationship, the fungal hyphae absorb essential minerals like phosphorus from the soil and transfer them to the plant. In return, the plant provides the fungus with carbohydrates, fostering a mutually beneficial nutrient exchange.

40. (4) molasses.
The industrial production of ethanol relies on the fermentation of various carbohydrate sources by yeast. In commercial distilleries, molasses—a byproduct of the sugar industry—is the most common and cost-effective substrate used. It contains high amounts of fermentable sugars that Saccharomyces cerevisiae can efficiently convert into ethanol. Other substrates like corn or soya can be used, but molasses remains the primary choice.

41. (1) Saccharomyces
Ethanol is a major industrial product manufactured through the process of fermentation. It is commercially produced using specific species of the yeast genus Saccharomyces, most notably Saccharomyces cerevisiae. This microbe, often called brewer's yeast, metabolizes sugars under anaerobic conditions to produce ethanol and carbon dioxide. This biological process is the foundation for the global alcoholic beverage and biofuel industries.

42. (3) purify enzymes
In industrial microbiology, 'fed-batch' fermentation involves the continuous or periodic addition of nutrients, such as sugars, during the process. This technique is used to maintain the microorganisms in their active growth phase and prevent nutrient depletion. It is particularly effective for maximizing the production and subsequent purification of extracellular enzymes and other secondary metabolites, ensuring high yields and consistent quality of the product.

43. (2) organ-transplant Trichoderma
Modern medicine utilizes bioactive molecules for critical procedures like organ transplantation. Cyclosporin A is a powerful immunosuppressive drug administered to organ-transplant patients to prevent the body's immune system from rejecting the new organ. This drug is naturally obtained from the fungus species Trichoderma polysporum. This relationship between a fungal product and clinical application highlights the importance of microbial diversity in healthcare.

44. (3) Clostridium butylicum - Lactic acid
Industrial microbial products are highly specific to the organisms used. Yeast is used for statins, Acetobacter aceti for acetic acid, and Aspergillus niger for citric acid. However, Clostridium butylicum is a bacterium that produces butyric acid, not lactic acid. Lactic acid is primarily produced by Lactic Acid Bacteria such as Lactobacillus. Such distinctions are essential for the correct application of microbes.

45. (4) biological process.
Sewage treatment consists of several distinct stages. While primary treatment is a physical process of filtration and sedimentation, secondary treatment is essentially a biological process. It involves the use of aerobic microorganisms in aeration tanks to consume the organic matter

NODIA

10. (3) A-III, B-I, C-IV, II
Industrial microbiology exploits diverse microbes for specific biochemical products. Clostridium butylicum is a bacterium used to produce butyric acid. Saccharomyces cerevisiae, or brewer's yeast, is fundamental in ethanol production through fermentation. Trichoderma polysporum is a fungus that yields cyclosporin A, an important immunosuppressant. Furthermore, Streptococcus species are used to produce streptokinase, which functions effectively as a medical clot-dissolving agent.

11. (2) (A), (B), (D), (E) only
Biochemical Oxygen Demand measures the oxygen required by microbes to decompose organic matter in water. Higher organic pollution increases BOD, which simultaneously depletes dissolved oxygen levels. This inverse relationship makes both parameters reliable indicators of water body health. When dissolved oxygen drops significantly due to high BOD, aquatic organisms often perish. These levels are directly influenced by the organic load present.

12. (1) Trichoderma polysporum
Cyclosporin A is a critical bioactive molecule used in modern medicine as an immunosuppressive agent for patients undergoing organ transplantation. It prevents the immune system from rejecting the new organ. This chemical is commercially produced through the fermentation process of the fungus Trichoderma polysporum. Understanding fungal metabolites has led to significant advancements in transplant surgery and various other clinical therapies.

13. (2) (iii) (i) (iv) (ii)
Different microbes are specialized for the production of specific organic acids through metabolic pathways. Aspergillus niger is a fungus used to produce citric acid. Acetobacter aceti is a bacterium responsible for converting ethanol into acetic acid. Clostridium butylicum is utilized for the industrial synthesis of butyric acid. Finally, Lactobacillus species are well known for converting lactose in milk into lactic acid.

14. (2) (ii) (i) (iv) (iii)
Industrial applications of microbes involve the extraction of various organic acids and bioactive molecules. Clostridium butylicum is the biological source for butyric acid production. Trichoderma polysporum yields the immunosuppressant cyclosporin A, vital for transplants. Monascus purpureus is used to produce statins, which help lower blood cholesterol. Aspergillus niger is primarily used for the commercial manufacture of citric acid in various industries.

15. (4) Activated sludge
During secondary sewage treatment, a small portion of the settled bacterial flocs, known as activated sludge, is recycled into the aeration tank as inoculum. The remaining major part of this activated sludge is pumped into large tanks called anaerobic sludge digesters. Here, anaerobic bacteria digest the fungi and bacteria present in the sludge, producing a mixture of gases like methane.

16. (3) Statin
Statins are bioactive molecules produced by the yeast Monascus purpureus. These chemicals are use1d commercially as blood cholesterol-lowering agents in patients with cardiovascular issues. Statins function by competitively inhibiting the enzyme responsible for the synthesis of cholesterol in the liver. This mechanism effectively reduces the overall level of cholesterol in the bloodstream, aiding in the prevention of heart-related diseases.

17. (3) Sacchromyces cerevisiae : Ethanol
Microbes are characterized by the specific metabolic products they generate during fermentation. Saccharomyces cerevisiae, commonly known as brewer's yeast, is extensively used for the commercial production of ethanol. While Lactobacillus produces lactic acid and Acetobacter aceti produces acetic acid, yeast remains the primary organism for alcoholic fermentation. Methanobacteria are typically involved in producing biogas, particularly methane, rather than producing organic acids.

18. (2) Trichoderma
Biocontrol refers to the use of biological methods for controlling plant diseases and pests. Trichoderma species are free-living fungi that are very common in the root ecosystems. They are effective biocontrol agents against several soil-borne plant pathogens. Unlike chemical pesticides, these biological agents are environmentally friendly and target specific pathogens without harming other beneficial organisms in the soil or the environment.

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55. (3) Oscillatoria.
Paddy fields provide a unique aquatic environment where nitrogen fixation is crucial for crop productivity. While various organisms contribute to soil fertility, Oscillatoria is a common nitrogen-fixing cyanobacterium found in these fields. Like other blue-green algae, it can convert atmospheric nitrogen into usable forms. This process enriches the soil naturally, reducing the dependence on synthetic nitrogenous fertilizers in traditional rice cultivation.

56. (4) Snail
Organic farming utilizes various biological agents to enhance soil health and manage pests. Glomus forms mycorrhiza for nutrient uptake, Earthworms improve soil aeration and composting, and Oscillatoria fixes nitrogen. However, snails are generally not used in organic farming as beneficial agents; in fact, many snail species are considered agricultural pests that damage crops by feeding on leaves and stems.

57. (2) Glomus
Mycorrhizae are categorized into ectomycorrhizae and endomycorrhizae based on the fungal penetration into root tissues. Endomycorrhizae, specifically Arbuscular Mycorrhizae, involve fungi that penetrate the cortical cells of the roots. The genus Glomus is a well-known example of an endomycorrhizal fungus. It forms specialized structures like arbuscules within the root cells, facilitating the efficient exchange of nutrients, particularly phosphorus, between the fungus and plant.

58. (1) Alcohol - Nitrogenase
Industrial processes utilize specific enzymes for efficiency. Pectinases clarify fruit juices, amylases are used in the textile industry to remove starch, and lipases help detergents remove oil stains. However, the production of alcohol involves fermentation by yeast, which utilizes the enzyme complex zymase. Nitrogenase is an enzyme exclusively found in nitrogen-fixing prokaryotes and is not involved in the industrial production of alcohol.

59. (3) Xanthomonas campestris
Biopesticides include various biological agents used to control pests. Trichoderma harzianum is a fungus used for biocontrol, Nucleopolyhedrovirus is an insect pathogen, and Bacillus thuringiensis is used against caterpillars. Xanthomonas campestris, however, is not a biopesticide; it is a pathogenic bacterium that causes diseases in plants, such as black rot in crucifers. It is also used industrially to produce xanthan gum.

60. (2) biological control of soil-borne plant pathogens
Trichoderma harzianum is a highly effective and widely used biological control agent in agriculture. It is a free-living fungus that thrives in the rhizosphere. Its primary utility lies in its ability to suppress various soil-borne plant pathogens through mechanisms such as competition for nutrients, production of inhibitory compounds, and direct parasitism of pathogenic fungi. This makes it a valuable tool for sustainable disease management.

61. (2) Paecilomyces lilacinus
Controlling nematodal diseases in plants is a significant challenge in agriculture. Paecilomyces lilacinus is a nematophagous fungus that has proved effective for the biological control of plant-parasitic nematodes. It works by infecting the eggs and adult stages of the nematodes, effectively reducing their population in the soil. This biological approach provides a non-toxic alternative to chemical nematicides, protecting crop health and soil biodiversity.

62. (1) Frankia
Nitrogen fixation in plants is often facilitated by symbiotic microorganisms. In the case of the non-leguminous plant Alnus, root nodules are formed by the actinomycete Frankia. This filamentous bacterium fixes atmospheric nitrogen into a form that the tree can assimilate. This partnership allows Alnus to thrive in nitrogen-deficient soils, demonstrating the diversity of nitrogen-fixing associations beyond the well-known Rhizobium-legume symbiosis.

63. (3) live microbial food supplement
Probiotics are defined as live microbial food supplements that provide health benefits to the host when consumed in adequate amounts. They primarily consist of beneficial bacteria like Lactobacillus and Bifidobacterium. These microorganisms help maintain a healthy balance of the gut microbiota, improve digestion, and enhance the immune system. They are commonly found in fermented dairy products like yogurt and specialized health supplements.

NODIA

1995

91. The rotenone is
(1) a natural herbicide
(2) a natural insecticide
(3) an insect hormone
(4) a bioherbicide.

1995

92. One of the major difficulties in the biological control of insect pest is that
(1) the method is less effective as compared with the use of insecticides
(2) the practical difficulty of introducing the predator to specific areas
(3) the predator develops a preference to other diets and may itself become a pest
(4) the predator does not always survive when transferred to a new environment.

1994

93. In cheese manufacture, the microorganisms are important for
(1) the ripening only
(2) the souring of milk only
(3) the development of resistance to spoilage only
(4) both the souring and the ripening processes.

1994

94. The main reason why antibodies could not solve all the problems of bacteria mediated disease is
(1) decreased efficiency of the immune system
(2) insensitivity of the individual following prolonged exposure to antibiotics
(3) development of mutant strains resistant to antibodies
(4) inactivation of antibiotics by bacterial enzymes.

1994

95. Biological control of agricultural pests, unlike chemical control, is
(1) self perpetuating
(2) polluting
(3) very expensive
(4) toxic.

1994

96. Which of the following species does not have the ability to fix atmospheric nitrogen?
(1) Azotobactor
(2) Anabaena
(3) Nostoc
(4) Spirogyra

1994

97. Which one of the following statements is correct?
(1) Legumes fix nitrogen only through the specialized bacteria that live in their roots.
(2) Legumes fix nitrogen independently of the specialized bacteria that live in their roots.
(3) Legumes fix nitrogen only through specialized bacteria that live in their leaves.
(4) Legumes are incapable of fixing nitrogen.

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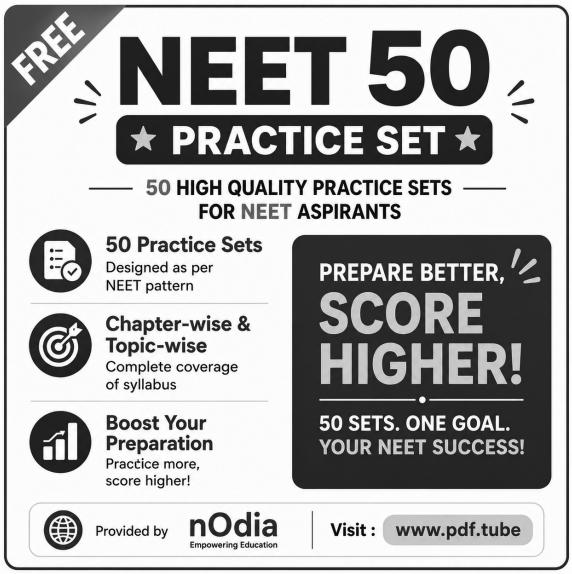

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The primary microorganisms responsible for this process are methanogens, such as Methanobacterium. These bacteria thrive in oxygen-free environments and convert the organic acids and hydrogen produced during the initial stages of decomposition into methane gas. Methanogens are also naturally found in the rumen of cattle and sewage sludge.

74. (1) Azolla and BGA
Biofertilizers are biological agents that enhance the nutrient availability in the soil. Azolla, an aquatic fern, and Blue-Green Algae (BGA), also known as cyanobacteria, form an excellent pair of biofertilizers. Many BGA species fix atmospheric nitrogen, and when associated with Azolla, they significantly boost the nitrogen content of paddy fields. This natural fertilization method is sustainable and helps reduce the use of expensive chemicals.

75. (2) Saccharomyces
The industrial manufacture of ethanol from starchy materials involves the breakdown of complex carbohydrates into fermentable sugars, followed by fermentation. The yeast genus Saccharomyces, particularly Saccharomyces cerevisiae, is the primary organism used for this fermentation. It efficiently converts sugars like glucose and maltose into ethanol and carbon dioxide. This biological process is utilized globally for beverage production and the synthesis of industrial spirits.

76. (1) Azolla
Azolla is a genus of small aquatic ferns that float on the surface of water in paddy fields. It is highly valued in agriculture because it harbors the nitrogen-fixing cyanobacterium Anabaena azollae in its leaf cavities. This symbiotic relationship allows for the continuous fixation of atmospheric nitrogen, which dramatically increases the fertility of the soil and the yield of the rice crop.

77. (3) Azolla
Among various ferns, Azolla stands out as an exceptional biofertilizer. This aquatic fern possesses a specialized symbiotic association with the nitrogen-fixing cyanobacterium Anabaena azollae. Because it can fix large amounts of atmospheric nitrogen and grows rapidly in waterlogged conditions, it is extensively used in rice cultivation. When the fern dies and decomposes, it releases accumulated nitrogen and organic matter into the soil.

78. (3) Anabaena
Rice yields can be significantly increased through the biological fixation of nitrogen in paddy fields. Anabaena is a genus of nitrogen-fixing cyanobacteria that can live freely in the water or in symbiotic association with the water fern Azolla. By converting atmospheric nitrogen into ammonia, these organisms provide a steady supply of nitrogenous nutrients to the rice plants, promoting healthier growth and higher productivity.

79. (2) ethanol
Saccharomyces cerevisiae, widely known as brewer's or baker's yeast, has immense industrial importance. Its most significant role in industrial production is the fermentation of sugars to produce ethanol. This process is the cornerstone of the brewing and distilling industries, where it is used to make beer, wine, and spirits. Additionally, yeast-derived ethanol is increasingly used as a renewable biofuel to reduce carbon emissions.

80. (1) Aspergillus niger
Citric acid is an important organic acid used in the food and pharmaceutical industries as a preservative and flavoring agent. The fungus Aspergillus niger is the primary microorganism used for its large-scale industrial production. Under specific controlled conditions, this fungus fermentatively converts carbohydrate-rich substrates like molasses into citric acid. This microbial method is preferred due to its efficiency and the high purity of the product.

81. (4) Pheromones
Agricultural production has evolved through different generations of pest control. While early methods used simple chemicals and later synthetic organophosphates, modern advanced agriculture utilizes third-generation pesticides like pheromones. Pheromones are chemical signals used by insects for communication, particularly for mating. By using synthetic pheromones, farmers can disrupt the mating cycles of pests or trap them effectively, providing a non-toxic and highly specific control method.

NODIA

2021

50. During the process of gene amplification using PCR, if very high temperature is not maintained in the beginning, then which of the following steps of PCR will be affected first?
(1) Ligation
(2) Annealing
(3) Extension
(4) Denaturation

2020

51. Identify the wrong statement with regard to restriction enzymes.
(1) Each restriction enzyme functions by inspecting the length of a DNA sequence.
(2) They cut the strand of DNA at palindromic sites.
(3) They are useful in genetic engineering.
(4) Sticky ends can be joined by using DNA ligases.

2020

52. Choose the correct pair from the following.
(1) Ligases - Join the two DNA molecules
(2) Polymerases - Break the DNA into fragments
(3) Nucleases - Separate the two strands of DNA
(4) Exonucleases - Make cuts at specific positions within DNA

2020

53. The specific palindromic sequence which is recognised by EcoRI is
(1) 5' - GAATTC - 3'
3' - CTTAAG - 5'
(2) 5' - GGAACC - 3'
3' - CCTTGG - 5'
(3) 5' - CTTAAG - 3'
3' - GAATTC - 5'
(4) 5' - GGATCC - 3'
3' - CCTAGG - 5'

2020

54. The sequence that controls the copy number of the linked DNA in the vector, is termed
(1) selectable marker
(2) Ori site
(3) palindromic sequence
(4) recognition site.

2020

55. In gel electrophoresis, separated DNA fragments can be visualized with the help of
(1) acetocarmine in bright blue light
(2) ethidium bromide in UV radiation
(3) acetocarmine in UV radiation
(4) ethidium bromide in infrared radiation.

2020

56. Match the organism with its use in biotechnology.

Column I (Organisms)			**Column II (Uses)**
A.	Bacillus thuringiensis	(i)	Cry proteins
B.	Thermus aquaticus	(ii)	DNA polymerase
C.	Agrobacterium tumefaciens	(iii)	Cloning vector
D.	Salmonella typhimurium	(iv)	Construction of first rDNA molecule

Select the correct option from the following.
(1) (A)-(ii); (B)-(iv); (C)-(iii); (D)-(i)
(2) (A)-(iv); (B)-(iii); (C)-(i); (D)-(ii)
(3) (A)-(iii); (B)-(ii); (C)-(iv); (D)-(i)
(4) (A)-(iii); (B)-(iv); (C)-(i); (D)-(ii)

2019

57. Following statements describe the characteristics of the enzyme restriction endonuclease. Identify the incorrect statement.
(1) The enzyme recognises a specific palindromic nucleotide sequence in the DNA.
(2) The enzyme cuts DNA molecule at identified position within the DNA.
(3) The enzyme binds DNA at specific sites and cuts only one of the two strands.
(4) The enzyme cuts the sugar-phosphate backbone at specific sites on each strand.

Odisha NEET 2019

58. A selectable marker is used to
(1) help in eliminating the non-transformants, so that the transformants can be regenerated
(2) identify the gene for a desired trait in an alien organism
(3) select a suitable vector for transformation in a specific crop
(4) mark a gene on a chromosome for isolation using restriction enzyme.

Odisha NEET 2019

59. Given below are four statements pertaining to separation of DNA fragments using gel electrophoresis. Identify the incorrect statements.
(i) DNA is negatively charged molecule and so it is loaded on gel towards the anode terminal.
(ii) DNA fragments travel along the surface of the gel whose concentration does not affect movement of DNA.

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91. (2) a natural insecticide
Rotenone is an odorless, colorless, crystalline isoflavone used as a broad-spectrum insecticide and piscicide. It occurs naturally in the seeds and roots of several plants, such as those in the genus Derris. As a natural insecticide, it works by interfering with the mitochondrial electron transport chain in insects. Because it is derived from plants and breaks down relatively quickly in the environment, it is considered a botanical pesticide.

92. (3) the predator develops a preference to other diets and may itself become a pest
One of the primary risks and difficulties in implementing biological control is the potential for non-target effects. If a natural predator introduced to control a specific pest lacks strict host specificity, it may begin to feed on beneficial organisms or other crops. In such cases, the intended biocontrol agent can itself become a new pest problem, disrupting the local ecosystem and failing to provide effective management.

93. (4) both the souring and the ripening processes.
Microorganisms are fundamental to every stage of cheese production. Initially, lactic acid bacteria are used for the souring of milk, where they convert lactose into lactic acid, causing the milk to curdle. Subsequently, different types of bacteria or fungi are employed during the ripening process. These microbes contribute to the development of the specific flavor, texture, and aroma that characterize different varieties of cheese.

94. (3) development of mutant strains resistant to antibodies
Despite the effectiveness of antibiotics in treating bacterial diseases, they have not solved all medical problems due to the evolution of bacteria. Through random mutations and horizontal gene transfer, bacteria can develop resistance to specific antibiotics. These resistant mutant strains survive and multiply, leading to infections that are difficult to treat with standard medications. This phenomenon of antibiotic resistance is a major global health challenge today.

95. (1) self perpetuating
Biological control of agricultural pests offers several advantages over chemical methods. Unlike chemical pesticides, which must be reapplied frequently, biological control is often self-perpetuating. Once a population of natural predators or parasites is established in the environment, they can continue to manage the pest population over multiple generations without further human intervention. This makes biological control a cost-effective and sustainable solution for long-term pest management.

96. (4) Spirogyra
Nitrogen fixation is a specialized metabolic capability found only in certain prokaryotic organisms. Bacteria like Azotobacter and cyanobacteria like Anabaena and Nostoc possess the nitrogenase enzyme required to convert atmospheric nitrogen into usable forms. However, Spirogyra is a filamentous green alga, which is a eukaryotic organism. It lacks the biological machinery for nitrogen fixation and depends on dissolved nitrogenous compounds in its aquatic environment for growth.

97. (1) Legumes fix nitrogen only through the specialized bacteria that live in their roots.
Leguminous plants are well known for their ability to improve soil fertility through nitrogen fixation. This process is not performed by the plants themselves but through a symbiotic association with specialized bacteria, primarily of the genus Rhizobium. These bacteria reside within nodules formed on the plant's roots. Within these nodules, the bacteria convert atmospheric nitrogen into ammonia, which the plant then uses for its growth.

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82. (4) Azotobacter
Nitrogen-fixing biofertilizers can be classified as symbiotic or non-symbiotic. Rhizobium forms nodules on legume roots, and Anabaena often associates with Azolla, making them symbiotic. VAM involves a symbiotic fungal association with roots. In contrast, Azotobacter is a genus of free-living, non-symbiotic bacteria that inhabit the soil. It fixes atmospheric nitrogen independently and enriches the soil with nitrogenous compounds that plants can subsequently absorb.

83. (4) Azolla pinnata
Farmers in many parts of the world, particularly in Asia, have reported substantial increases in rice yields by using Azolla pinnata as a biofertilizer. This aquatic fern harbors nitrogen-fixing cyanobacteria that provide an abundant supply of nitrogen to the paddy fields. When integrated into the rice-growing cycle, Azolla can supplement or even replace chemical fertilizers, leading to more sustainable and productive agricultural systems.

84. (4) $CH_4 + CO_2$.
Gobar gas, or biogas, is a mixture of several gases produced by the anaerobic decomposition of animal waste. The two most significant and predominant components of this gas mixture are methane and carbon dioxide. Methane typically constitutes about 50% to 70% of the gas, providing its fuel value, while carbon dioxide makes up about 30% to 40%. Trace amounts of other gases are also present.

85. (1) Anabaena and Azolla
Biofertilizers are living organisms that enhance soil fertility by increasing nutrient availability. Anabaena, a nitrogen-fixing cyanobacterium, and Azolla, an aquatic fern that hosts Anabaena, are classic examples of biofertilizers. Unlike traditional manures or chemical fertilizers, these biological agents fix atmospheric nitrogen directly into the ecosystem. This natural process improves crop yields, particularly in rice cultivation, while maintaining the long-term health of the agricultural environment.

86. (2) Antibiotics are capable of curing any disease.
Antibiotics are powerful chemicals produced by microorganisms that can inhibit the growth of or kill other microbes. While they have revolutionized medicine, it is false to claim they can cure any disease. Antibiotics are specifically effective against bacterial infections and have no effect on viral diseases like the common cold or flu. Furthermore, some individuals may experience allergic reactions to certain antibiotics like penicillin.

87. (1) cactus prevention
Biological control often involves introducing a natural enemy to manage an invasive plant species. Cochineal insects, which are scale insects of the genus Dactylopius, have been successfully used for the control and prevention of invasive prickly pear cacti. By feeding on the cactus pads, these insects weaken and eventually kill the plant. This method has been historically important in controlling cactus overgrowth in various regions.

88. (3) biological control
Biological control is a method of managing pests, such as insects, mites, weeds, and plant diseases, using other living organisms. It relies on natural ecological interactions like predation, parasitism, and herbivory. By introducing or encouraging natural predators to target specific pathogens or pests, farmers can reduce their reliance on chemical pesticides. This approach is a core component of sustainable agriculture and integrated pest management strategies.

89. (3) Aspergillus niger
The industrial synthesis of citric acid is primarily achieved through the fermentation of sugar-containing substrates by the fungus Aspergillus niger. This microbe is exceptionally efficient at converting carbohydrates into citric acid under acidic conditions. Because of its high yield and the relative ease of processing, Aspergillus niger has remained the preferred industrial organism for citric acid production for decades, serving various global sectors.

90. (2) Saccharomyces
Alcohol fermentation is a biological process where sugars are converted into cellular energy, producing ethanol and carbon dioxide as metabolic byproducts. The organism most commonly and effectively used for this purpose in both traditional and industrial settings is the yeast genus Saccharomyces, specifically Saccharomyces cerevisiae. Its ability to tolerate high concentrations of ethanol and ferment various sugars makes it indispensable for the alcoholic beverage industry.

NODIA

C. Fusion of protoplasts to get hybrid protoplast.
D. Isolation of single cells from two different varieties of plants.
E. Growing of hybrid protoplast to form a new plant.
(1) D, A, B, C, E
(2) E, B, A, D, C
(3) D, B, A, E, C
(4) E, A, B, C, D

2026 (CANCELLED)

9. Which of the following statements are NOT true regarding restriction endonucleases?
A. They are called molecular scissors.
B. These are the enzymes responsible for restricting the growth of bacteriophages in E. coli.
C. They cut the DNA only at the centre of the palindromic sites.
D. They remove nucleotides only from the ends of DNA fragments.
E. They recognise specific palindromic base-pair sequences.
(1) A and B only (2) A and E only
(3) D and E only (4) C and D only

2026 (CANCELLED)

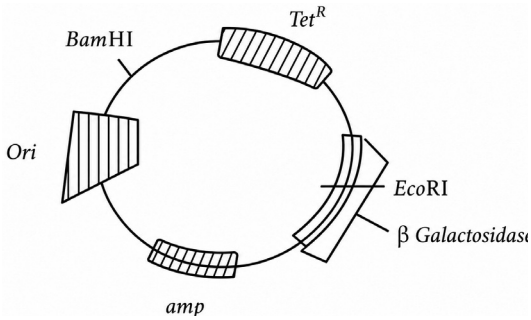
10. Which of the following statements are correct with respect to DNA separation, isolation and visualization?
A. The cutting of DNA is done by molecular scissors.
B. The DNA fragments separate according to their size in an agarose gel, upon electrophoresis.
C. The separated DNA fragments can be seen without staining when exposed to UV light.
D. The separated DNA fragments, when stained with ethidium bromide, can be seen in visible light.
Choose the correct answer from the options given below :
(1) B and D only (2) A and B only
(3) B and C only (4) A and D only

2026 (CANCELLED)

11. Insertion of a foreign DNA at BamHI site in an E. coli cloning vector pBR322 results in the loss of antibiotic resistance towards:
(1) Ampicillin and tetracycline
(2) Ampicillin
(3) Tetracycline
(4) Gentamycin

2025

12.



In the above represented plasmid an alien piece of DNA is inserted at EcoRI site. Which of the following strategies will be chosen to select the recombinant colonies?
(1) White color colonies will be selected.
(2) Blue color colonies grown on ampicillin plates can be selected.
(3) Using ampicillin & tetracyclin containing medium plate.
(4) Blue color colonies will be selected.

2025

13. The blue and white selectable markers have been developed which differentiate recombinant colonies from non-recombinant colonies on the basis of their ability to produce colour in the presence of a chromogenic substrate.
Given below are two statements about this method:
Statement I: The blue coloured colonies have DNA insert in the plasmid and they are identified as recombinant colonies.
Statement II: The colonies without blue colour have DNA insert in the plasmid and are identified as recombinant colonies.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

2025

14. Which of the following enzyme(s) are not essential for gene cloning?
A. Restriction enzymes
B. DNA ligase

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Manipur NEET 2023

30. Ligation of foreign DNA at which of the following site will result in loss of tetracycline resistance of pBR322?
(1) Pst I (2) Pvu I
(3) EcoR I (4) BamH I

Manipur NEET 2023

31. Which of the following statement is incorrect about Agrobacterium tumefaciens?
(1) It is used to deliver gene of interest in both prokaryotic as well as eukaryotic host cells.
(2) 'Ti' plasmid from Agrobacterium tumefaciens used for gene transfer is not pathogenic to plant cell.
(3) It transforms normal plant cells into tumor cells.
(4) It delivers 'T-DNA' into plant cell.

Manipur NEET 2023

32. Match List I with List II.

	List-I		List-II
A.	Kanamycin	I.	Delivers genes into animal cells
B.	Cla I	II.	Selectable marker
C.	Disarmed retroviruses	III.	Restriction site
D.	KanamycinR gene	IV.	Antibiotic resistance

Choose the correct answer from the options given below.
(1) (A)-(II), (B)-(III), (C)-(I), (D)-(IV)
(2) (A)-(III), (B)-(I), (C)-(IV), (D)-(II)
(3) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)
(4) (A)-(II), (B)-(IV), (C)-(I), (D)-(III)

2023

33. Upon exposure to UV radiation, DNA stained with ethidium bromide will show
(1) bright yellow colour
(2) bright orange colour
(3) bright red colour
(4) bright blue colour.

2023

34. In gene gun method used to introduce alien DNA into host cells, microparticles of _____ metal are used.
(1) tungsten or gold
(2) silver
(3) copper
(4) zinc

2023

35. Which of the following is not a cloning vector?
(1) pBR322
(2) Probe
(3) BAC
(4) YAC

Manipur NEET 2023

36. Thermostable DNA polymerase used in PCR was isolated from
(1) Thermus aquaticus
(2) Escherichia coli
(3) Agrobacterium tumefaciens
(4) Bacillus thuringiensis.

2023

37. Main steps in the formation of recombinant DNA are given below. Arrange these steps in a correct sequence.
A. Insertion of recombinant DNA into the host cell.
B. Cutting of DNA at specific location by restriction enzyme.
C. Isolation of desired DNA fragment.
D. Amplification of gene of interest using PCR.
Choose the correct answer from the options given below :
(1) C, B, D, A
(2) B, D, A, C
(3) B, C, D, A
(4) C, A, B, D

NODIA

2023

38. During the purification process for recombinant DNA technology, addition of chilled ethanol precipitates out
(1) histones
(2) polysaccharides
(3) RNA
(4) DNA.

2022

39. Which one of the following statement is not true regarding gel electrophoresis technique?
(1) The process of extraction of separated DNA strands from gel is called elution.
(2) The separated DNA fragments are stained by using ethidium bromide.
(3) The presence of chromogenic substrate gives blue coloured DNA bands on the gel.
(4) Bright orange coloured bands of DNA can be observed in the gel when exposed to UV light.

RE-EXAM 2024

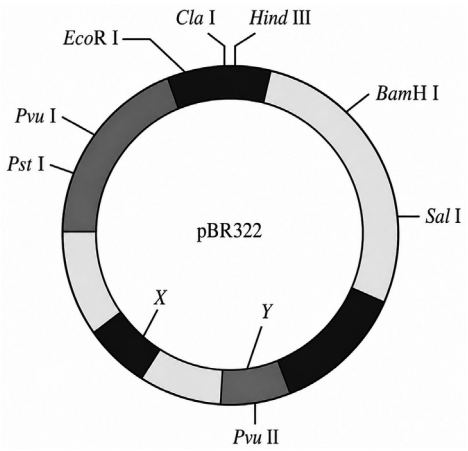
22. Select the restriction endonuclease enzymes whose restriction sites are present for the tetracycline resistance (tetR) gene in the pBR322 cloning vector.
(1) BamH I and Sal I
(2) Sal I and Pst I
(3) Pst I and Pvu I
(4) Pvu I and BamH I

RE-EXAM 2024

23. Which of the following are correct about EcoRI?
A. Cut the DNA with blunt end
B. Cut the DNA with sticky end
C. Recognises a specific palindromic sequence
D. Cut the DNA between the base G and A when encounters the DNA sequence 'GAATTC'
E. Exonuclease
Choose the correct answer from the options given below.
(1) B, C, E only
(2) A, D, E only
(3) A, C, D only
(4) B, C, D only

2024

24. The following diagram showing restriction sites in E.coli cloning vector or pBR322. Find the role of 'X' and 'Y' genes.



(1) The gene 'X' is responsible for resistance to antibiotics and 'Y' for protein involved in the replication of Plasmid.
(2) The gene 'Y' is responsible for controlling the copy number of the linked DNA and 'X' for protein involved in the replication of Plasmid.
(3) The gene 'X' is for protein involved in replication of Plasmid and 'Y' for resistance to antibiotics.
(4) Gene 'X' is responsible for recognition sites and 'Y' is responsible for antibiotic resistance.

2024

25. The 'Ti plasmid" of Agrobacterium tumefaciens stands for
(1) tumor inhibiting plasmid
(2) tumor independent plasmid
(3) tumor inducing plasmid
(4) temperature independent plasmid.

2024

26. Hind II always cuts DNA molecules at a particular point called recognition sequence and it consists of
(1) 8 bp (2) 6 bp
(3) 4 bp (4) 10 bp.

RE-EXAM 2024

27. Following are the steps involved in the process of PCR
A. Annealing
B. Amplification (~ 1 billion times)
C. Denaturation
D. Treatment with Taq polymerase and deoxynucleotides.
E. Extension
Choose the correct sequence of steps of PCR from the options given below.
(1) C → A → D → E → B
(2) A → B → E → D → C
(3) A → C → E → D → B
(4) D → B → E → C → A

2024

28. Which of the following statements is incorrect ?
(1) A bio-reactor provides optimal growth conditions for achieving the desired product.
(2) Most commonly used bio-reactors are of stirring type.
(3) Bio-reactors are used to produce small scale bacterial cultures.
(4) Bio-reactors have an agitator system, an oxygen delivery system and foam control system.

Manipur NEET 2023

29. Which of the following can act as molecular scissors?
(1) Restriction enzymes
(2) DNA ligase
(3) RNA polymerase
(4) DNA polymerase

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CHAPTER 28

Biotechnology : Principles and Processes

2026 (RE-NEET)

1. Assertion A: In recombinant DNA technology, lysozyme is used for disrupting bacterial cells while cellulase is for plant cells. Reason R: Isolation of genetic material needs disruption of cells.
(1) A is correct but R is not correct
(2) A is not correct but R is correct
(3) Both A and R are correct and R is the correct explanation of A
(4) Both A and R are correct but R is not the correct explanation of A

2026 (RE-NEET)

2. Given below are two statements
Statement I: Plasmids are autonomously replicating DNA.
Statement II: Plasmids are extrachromosomal DNA.
(1) Statement I is correct but Statement II is incorrect
(2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are correct
(4) Both Statement I and Statement II are incorrect

2026 (RE-NEET)

3. During PCR, primers bind to the DNA strands in the ___ step.
(1) annealing
(2) ligation
(3) denaturation
(4) extension

2026 (RE-NEET)

4. Match List-I with List-II:
A. Transformation; B. Cloning site; C. Selection; D. Ori. (I. Restriction enzyme, II. Transfer DNA to host bacteria, III. Replication, IV. Antibiotic)
(1) A-III, B-IV, C-II, D-I
(2) A-IV, B-I, C-III, D-II
(3) A-II, B-I, C-IV, D-III
(4) A-I, B-II, C-IV, D-III

2026 (CANCELLED)

5. Match List I with List II:
List I:
A. Genetically modified organism
B. Thermostable DNA polymerase
C. Ti plasmid
D. pBR322
List II:
I. Agrobacterium tumefaciens
II. Bt cotton
III. Thermus aquaticus
IV. Escherichia coli
(1) A-II, B-III, C-I, D-IV
(2) A-II, B-I, C-IV, D-III
(3) A-I, B-IV, C-III, D-II
(4) A-I, B-II, C-IV, D-III

2026 (CANCELLED)

6. Identify the correct sequence of steps in each cycle of Polymerase Chain Reaction:
(1) Extension → Annealing → Denaturation
(2) Annealing → Denaturation → Extension
(3) Denaturation → Extension → Annealing
(4) Denaturation → Annealing → Extension

2026 (CANCELLED)

7. Arrange the following steps of DNA fingerprinting in a correct sequence.
A. Isolation of DNA and its digestion by restriction endonucleases.
B. Hybridisation using a labelled VNTR probe.
C. Transferring of separated DNA fragments to synthetic membranes.
D. Detection of hybridised DNA fragments by autoradiography.
E. Separation of DNA fragments by electrophoresis.
(1) A, B, D, C, E
(2) A, D, B, E, C
(3) A, E, C, B, D
(4) A, E, B, C, D

2026 (CANCELLED)

8. Arrange the following steps of somatic hybridisation in a correct sequence.
A. Digestion of cell walls.
B. Isolation of naked protoplasts.

NODIA

2022

40. In the following palindromic base sequences of DNA, which one can be cut easily by particular restriction enzyme?
(1) 5' G A T A C T 3' ; 3' C T A T G A 5'
(2) 5' G A A T T C 3' ; 3' C T T A A G 5'
(3) 5' C T C A G T 3' ; 3' G A G T C A 5'
(4) 5' G T A T T C 3' ; 3' C A T A A G 5'

2022

41. Given below are two statements:
Statement I: Restriction endonucleases recognise specific sequence to cut DNA known as palindromic nucleotide sequence.
Statement II: Restriction endonucleases cut the DNA strand a little away from the centre of the palindromic site.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Both Statement I and Statement II are correct.
(2) Both Statement I and Statement II are incorrect.
(3) Statement I is correct but Statement II is incorrect.
(4) Statement I is incorrect but Statement II is correct.

2022

42. Which of the following is not a desirable feature of a cloning vector?
(1) Presence of origin of replication
(2) Presence of a marker gene
(3) Presence of single restriction enzyme site
(4) Presence of two or more recognition sites

2022

43. Given below are two statements : one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A) : Polymerase chain reaction is used in DNA amplification.
Reason (R) : The ampicillin resistant gene is used as a selectable marker to check transformation.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both (A) and (R) are correct and (R) is the correct explanation of (A).
(2) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
(3) (A) is correct but (R) is not correct.
(4) (A) is not correct but (R) is correct.

2021

44. DNA strands on a gel stained with ethidium bromide when viewed under UV radiation, appear as
(1) bright blue bands
(2) yellow bands
(3) bright orange bands
(4) dark red bands.

2021

45. Plasmid pBR322 has PstI restriction enzyme site within gene ampR that confers ampicillin resistance. If this enzyme is used for inserting a gene for β-galactoside production and the recombinant plasmid is inserted in an E.coli strain.
(1) It will be able to produce a novel protein with dual ability.
(2) It will not be able to confer ampicillin resistance to the host cell.
(3) The transformed cells will have the ability to resist ampicillin as well as produce β-galactoside.
(4) It will lead to lysis of host cell.

2021

46. A specific recognition sequence identified by endonucleases to make cuts at specific positions within the DNA is
(1) poly (A) tail sequences
(2) degenerate primer sequence
(3) okazaki sequences
(4) palindromic nucleotide sequences.

2021

47. Which of the following is a correct sequence of steps in a PCR (Polymerase Chain Reaction)?
(1) Annealing, Denaturation, Extension
(2) Denaturation, Annealing, Extension
(3) Denaturation, Extension, Annealing
(4) Extension, Denaturation, Annealing

2021

48. During the purification process for recombinant DNA technology, addition of chilled ethanol precipitates out
(1) polysaccharides (2) RNA
(3) DNA (4) histones.

2021

49. Which of the following is not an application of PCR (Polymerase Chain Reaction)?
(1) Detection of gene mutation
(2) Molecular diagnosis
(3) Gene amplification
(4) Purification of isolated protein

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C. DNA mutase
D. DNA recombinase
E. DNA polymerase
Choose the correct answer from the options given below.
(1) D and E only
(2) B and C only
(3) C and D only
(4) A and B only

2025

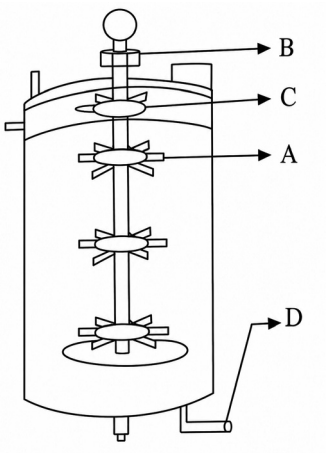
15. Given below are two statements :
Statement I : The DNA fragments extracted from gel electrophoresis can be used in construction of recombinant DNA.
Statement II : Smaller size DNA fragments are observed near anode while larger fragments are found near the wells in an agarose gel.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

2025

16. Polymerase chain reaction (PCR) amplifies DNA following the equation.
(1) $2n + 1$ (2) $2N^2$
(3) N^2 (4) 2^n

2025

17. Identify the part of a bio-reactor which is used as a foam braker from the given figure.



(1) D
(2) C
(3) A
(4) B

2024

18. What is the fate of a piece of DNA carrying only gene of interest which is transferred into an alien organism?
A. The piece of DNA would be able to multiply itself independently in the progeny cells of the organism.
B. It may get integrated into the genome of the recipient.
C. It may multiply and be inherited along with the host DNA.
D. The alien piece of DNA is not an integral part of chromosome.
E. It shows ability to replicate.
Choose the correct answer from the options given below.
(1) A and B only
(2) D and E only
(3) B and C only
(4) A and E only

RE-EXAM 2024

19. In a chromosome, there is a specific DNA sequence, responsible for initiating replication. It is called as
(1) recognition sequence
(2) cloning site
(3) restriction site
(4) ori site.

RE-EXAM 2024

20. Identify the incorrect statement related to gel electrophoresis.
(1) Separated DNA fragments can be directly seen under UV radiation.
(2) Separated DNA can be extracted from gel piece.
(3) Fragment of DNA moves toward anode.
(4) Sieving effect of agarose gel helps in separation of DNA fragments.

NODIA

RE-EXAM 2024

21. Recombinant DNA molecule can be created normally by cutting the vector DNA and source DNA respectively with
(1) Hind II, Hind II
(2) Hind II, Alu I
(3) Hind II, EcoR I
(4) Hind II, BamH I.

(iii) Smaller the size of DNA fragment larger is the distance it travels through it.
(iv) Pure DNA can be visualized directly by exposing UV radiation.
Choose correct answer from the options given below.
(1) (i), (iii) and (iv)
(2) (i), (ii) and (iii)
(3) (ii), (iii) and (iv)
(4) (i), (ii) and (iv)

2019

60. DNA precipitation out of a mixture of biomolecules can be achieved by treatment with
(1) chilled chloroform
(2) isopropanol
(3) chilled ethanol
(4) methanol at room temperature.

2019

61. Which one of the following equipments is essentially required for growing microbes on a large scale, for industrial production of enzymes?
(1) Bioreactor
(2) BOD incubator
(3) Sludge digester
(4) Industrial oven

2018

62. Which of the following is commonly used as a vector for introducing a DNA fragment in human lymphocytes?
(1) Retrovirus (2) Ti plasmid
(3) λ phage (4) pBR322

2018

63. The correct order of steps in Polymerase Chain Reaction (PCR) is
(1) extension, denaturation, annealing
(2) annealing, extension, denaturation
(3) denaturation, extension, annealing
(4) denaturation, annealing, extension.

2017

64. The DNA fragments separated on an agarose gel can be visualised after staining with
(1) acetocarmine
(2) aniline blue
(3) ethidium bromide
(4) bromophenol blue.

2017

65. DNA fragments are
(1) negatively charged
(2) neutral
(3) either positively or negatively charged depending on their size
(4) positively charged.

2017

66. A gene whose expression helps to identify transformed cell is known as
(1) vector
(2) plasmid
(3) structural gene
(4) selectable marker.

2017

67. What is the criterion for DNA fragments movement on agarose gel during gel electrophoresis ?
(1) The smaller the fragment size, the farther it moves.
(2) Positively charged fragments move to farther end.
(3) Negatively charged fragments do not move.
(4) The larger the fragment size, the farther it moves.

2017

68. The process of separation and purification of expressed protein before marketing is called
(1) downstream processing
(2) bioprocessing
(3) postproduction processing
(4) upstream processing.

NODIA

NEET-II 2016

69. A foreign DNA and plasmid cut by the same restriction endonuclease can be joined to form a recombinant plasmid using
(1) EcoRI
(2) Taq polymerase
(3) polymerase III
(4) ligase.

NEET-II 2016

70. Which of the following restriction enzymes produces blunt ends?
(1) SalI
(2) EcoRV
(3) XhoI
(4) HindIII

NEET-I 2016

71. Which of the following is not a feature of the plasmids?
(1) Transferable
(2) Single-stranded
(3) Independent replication
(4) Circular structure

NEET-I 2016

72. Which of the following is a restriction endonuclease?
(1) DNase I
(2) RNase
(3) Hind II
(4) Protease

NEET-II 2016

73. Stirred-tank bioreactors have been designed for
(1) purification of product
(2) addition of preservatives to the product
(3) availability of oxygen throughout the process
(4) ensuring anaerobic conditions in the culture vessel.

NEET-II 2016

74. Which of the following is not a component of downstream processing?
(1) Separation
(2) Purification
(3) Preservation
(4) Expression

NEET-I 2016

75. The Taq polymerase enzyme is obtained from
(1) Bacillus subtilis
(2) Pseudomonas putida
(3) Thermus aquaticus
(4) Thiobacillus ferrooxidans.

2015

76. The DNA molecule to which the gene of interest is integrated for cloning is called
(1) template
(2) carrier
(3) transformer
(4) vector.

2015

77. The cutting of DNA at specific locations became possible with the discovery of
(1) selectable markers
(2) ligases
(3) restriction enzymes
(4) probes.

2015

78. The introduction of T-DNA into plants involves
(1) exposing the plants to cold for a brief period
(2) allowing the plant roots to stand in water
(3) infection of the plant by Agrobacterium tumefaciens
(4) altering the pH of the soil, then heat-shocking the plants.

2014

79. Which vector can clone only a small fragment of DNA?
(1) Bacterial artificial chromosome
(2) Yeast artificial chromosome
(3) Plasmid
(4) Cosmid

2014

80. Commonly used vectors for human genome sequencing are
(1) T - DNA
(2) BAC and YAC
(3) expression vectors
(4) T/A cloning vectors.

2014

81. An analysis of chromosomal DNA using the Southern hybridisation technique does not use
(1) electrophoresis
(2) blotting
(3) autoradiography
(4) PCR.

2014

82. In vitro clonal propagation in plants is characterized by
(1) PCR and RAPD
(2) Northern blotting
(3) electrophoresis and HPLC
(4) microscopy.

2013

83. The colonies of recombinant bacteria appear white in contrast to blue colonies of non-recombinant bacteria because of
(1) insertional inactivation of alpha galactosidase in recombinant bacteria
(2) inactivation of glycosidase enzyme in recombinant bacteria
(3) non-recombinant bacteria containing beta galactosidase
(4) insertional inactivation of alpha galactosidase in non-recombinant bacteria.

2013

84. DNA fragments generated by the restriction endonucleases in a chemical reaction can be separated by
(1) electrophoresis
(2) restriction mapping
(3) centrifugation
(4) polymerase chain reaction.

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2013

85. Which of the following is not correctly matched for the organism and its cell wall degrading enzyme?
(1) Algae – Methylase
(2) Fungi – Chitinase
(3) Bacteria – Lysozyme
(4) Plant cells – Cellulase

Karnataka NEET 2013

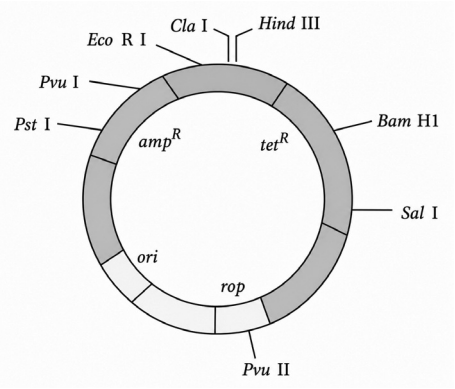
86. During the process of isolation of DNA, chilled ethanol is added to
(1) precipitate DNA
(2) break open the cell to release DNA
(3) facilitate action of restriction enzymes
(4) remove proteins such as histones.

2012

87. Which one of the following is a case of wrong matching?
(1) Somatic hybridisation - Fusion of two diverse cells
(2) Vector DNA - Site for tRNA synthesis
(3) Micropropagation - In vitro production of plants in large numbers
(4) Callus - Unorganised mass of cells produced in tissue culture

2012

88. The given figure is the diagrammatic representation of the E. coli vector pBR322. Which one of the given options correctly identifies its certain component(s)?



(1) ori-original restriction enzyme
(2) rop-reduced osmotic pressure
(3) HindIII, EcoRI - selectable markers
(4) ampR, tetR-antibiotic resistance genes

2012

89. A single strand of nucleic acid tagged with a radioactive molecule is called
(1) vector
(2) selectable marker
(3) plasmid
(4) probe.

2012

90. For transformation, micro-particles coated with DNA to be bombarded with gene gun are made up of
(1) silver or platinum
(2) platinum or zinc
(3) silicon or platinum
(4) gold or tungsten.

Mains 2012

91. Biolistics (gene-gun) is suitable for
(1) disarming pathogen vectors
(2) transformation of plant cells
(3) constructing recombinant DNA by joining with vectors
(4) DNA fingerprinting.

Mains 2012

92. In genetic engineering, the antibiotics are used
(1) as selectable markers
(2) to select healthy vectors
(3) as sequences from where replication starts
(4) to keep the cultures free of infection.

Mains 2012

93. Which one of the following represents a palindromic sequence in DNA?
(1) 5' - GAATTC - 3'
3' - CTTAAG - 5'
(2) 5' - CCAATG - 3'
3' - GAATCC - 5'
(3) 5' - CATTAG - 3'
3' - GATAAC - 5'
(4) 5' - GATACC - 3'
3' - CCTAAG - 5'

2012

94. PCR and restriction fragment length polymorphism are the methods for
(1) study of enzymes
(2) genetic transformation
(3) DNA sequencing
(4) genetic fingerprinting.

2012

95. Which one is a true statement regarding DNA polymerase used in PCR?
(1) It is used to ligate introduced DNA in recipient cells.
(2) It serves as a selectable marker.
(3) It is isolated from a virus.
(4) It remains active at high temperature.

NODIA

22. (1) BamH I and Sal I
The pBR322 plasmid is a widely used cloning vector that contains several unique restriction sites within its antibiotic resistance genes. The tetracycline resistance gene specifically contains the recognition sequences for the restriction endonucleases BamH I and Sal I. Inserting foreign DNA at either of these sites results in the loss of tetracycline resistance through the process of insertional inactivation.

23. (4) B, C, D only
EcoRI is a restriction endonuclease that recognizes the specific palindromic nucleotide sequence GAATTC. It functions by cutting each of the two DNA strands at a specific point between the guanine and adenine bases. This asymmetric cleavage produces overhanging single-stranded segments known as sticky ends, which facilitate the joining of DNA fragments from different sources using the enzyme DNA ligase.

24. (2) The gene 'Y' is responsible for controlling the copy number of the linked DNA and 'X' for protein involved in the replication of Plasmid.
In the pBR322 plasmid vector, the origin of replication is the sequence responsible for initiating DNA replication and determining the copy number of the plasmid within the host cell. The rop gene codes for proteins that are involved in the replication process of the plasmid. Understanding these components is essential for effectively managing gene cloning and achieving optimal protein expression levels.

25. (3) tumor inducing plasmid
The Ti plasmid, found in the bacterium Agrobacterium tumefaciens, is a tumor-inducing plasmid. In nature, this bacterium uses the plasmid to transfer a specific segment of DNA into plant cells, which then integrates into the plant genome. This genetic transformation causes the plant cells to proliferate uncontrollably, leading to the natural formation of galls or large plant tumors.

26. (2) 6 bp
Hind II was the first restriction endonuclease to be isolated and characterized. It functions by recognizing a specific sequence of six base pairs in the DNA molecule and cutting the strands at a particular point. This specificity ensures that the enzyme consistently produces predictable fragments, which is a fundamental requirement for mapping genomes and creating complex recombinant DNA molecules in biotechnology.

27. (1) C → A → D → E → B
The polymerase chain reaction follows a precise sequence of events to amplify DNA. It begins with denaturation at high temperatures to separate the DNA strands. This is followed by annealing, where primers bind to the target sequences. Extension occurs as Taq polymerase adds nucleotides. These steps are repeated many times to achieve a massive increase in the DNA copies.

28. (3) Bio-reactors are used to produce small scale bacterial cultures.
Bioreactors are specialized vessels designed for the large-scale production of biological products, such as enzymes, proteins, or whole cells. Unlike laboratory flasks used for small-scale cultures, bioreactors can process volumes ranging from one hundred to one thousand liters. They provide controlled environments with systems for agitation, aeration, temperature regulation, and pH monitoring to ensure the maximum possible product yield.

29. (1) Restriction enzymes
Restriction enzymes, also known as restriction endonucleases, act as molecular scissors in biotechnology. They are capable of recognizing specific nucleotide sequences within a DNA molecule and cutting the sugar-phosphate backbone at precise locations. This ability to precisely slice DNA is fundamental to genetic engineering, allowing researchers to isolate genes and construct complex recombinant DNA molecules for many various applications.

30. (4) BamH I
The pBR322 plasmid vector contains two primary antibiotic resistance genes: ampicillin resistance and tetracycline resistance. The BamH I restriction site is located within the coding sequence of the tetracycline resistance gene. When foreign DNA is ligated at this site, the gene's function is disrupted through insertional inactivation, causing the host bacteria to lose their ability to survive on tetracycline.

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about which one or more of these can be used as a vector/vectors.
(i) Bacterium
(ii) Plasmid
(iii) Plasmodium
(iv) Bacteriophage

(1) (i), (ii) and (iv)
(2) (i) only
(3) (i) and (iii)
(4) (ii) and (iv)

2010

107. Stirred-tank bioreactors have been designed for
(1) addition of preservatives to the product
(2) purification of the product
(3) ensuring anaerobic conditions in the culture vessel
(4) availability of oxygen throughout the process.

2009

108. Polyethylene glycol method is used for
(1) biodiesel production
(2) seedless fruit production
(3) energy production from sewage
(4) gene transfer without a vector.

2009

109. Which one of the following is commonly used in transfer of foreign DNA into crop plants?
(1) Meloidogyne incognita
(2) Agrobacterium tumefaciens
(3) Penicillium expansum
(4) Trichoderma harzianum

2008

110. Gel electrophoresis is used for
(1) construction of recombinant DNA by joining with cloning vectors
(2) isolation of DNA molecules
(3) cutting of DNA into fragments
(4) separation of DNA fragments according to their size.

2008

111. The linking of antibiotic resistance gene with the plasmid vector became possible with
(1) DNA polymerase
(2) exonucleases
(3) DNA ligase
(4) endonucleases.

2006

112. Restriction endonuclease
(1) synthesizes DNA
(2) cuts the DNA molecule randomly
(3) cuts the DNA molecule at specific sites
(4) restricts the synthesis of DNA inside the nucleus.

2006

113. Two microbes found to be very useful in genetic engineering are
(1) crown gall bacterium and Caenorhabditis elegans
(2) Escherichia coli and Agrobacterium tumefaciens
(3) Vibrio cholerae and a tailed bacteriophage
(4) Diplococcus sp. and Pseudomonas sp.

2004

114. Restriction endonucleases
(1) are present in mammalian cells for degradation of DNA when the cell dies
(2) are used in genetic engineering for ligating two DNA molecules
(3) are used for in vitro DNA synthesis
(4) are synthesized by bacteria as part of their defense mechanism.

2004

115. The Ti plasmid, is often used for making transgenic plants. The plasmid is found in
(1) Azotobacter
(2) Rhizobium of the roots of leguminous plants
(3) Agrobacterium
(4) Yeast as a 2 mm plasmid.

2004

116. The most thoroughly studied of the known bacteria-plant interactions is the
(1) cyanobacterial symbiosis with some aquatic ferns
(2) gall formation on certain angiosperms by Agrobacterium
(3) nodulation of Sesbania stems by nitrogen fixing bacteria
(4) plant growth stimulation by phosphate-solubilising bacteria.

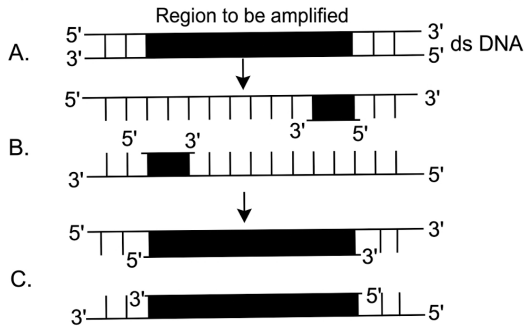
2003

117. Which one of the following bacteria has found extensive use in genetic engineering work in plants ?
(1) Clostridium septicum
(2) Xanthomonas citri
(3) Bacillus coagulans
(4) Agrobacterium tumefaciens

NODIA

Mains 2012

96. The figure below shows three steps (A, B, C) of Polymerase Chain Reaction (PCR). Select the option giving correct identification together with what it represents?



(1) B - denaturation at a temperature of about 98°C separating the two DNA strands
(2) A - denaturation at a temperature of about 50°C
(3) C - extension in the presence of heat stable DNA polymerase
(4) A - annealing with two sets of primers

Mains 2011

97. Which one of the following techniques made it possible to genetically engineer living organisms?
(1) Recombinant DNA techniques
(2) X-ray diffraction
(3) Heavier isotope labelling
(4) Hybridization

2011

98. Given below is a sample of a portion of DNA strand giving the base sequence on the opposite strands. What is so special shown in it?
5'___GAATTC___3'
3'___CTTAAG___5'
(1) Replication completed
(2) Deletion mutation
(3) Start codon at the 5' end
(4) Palindromic sequence of base pairs

2011

99. There is a restriction endonuclease called EcoRI. What does "co" part in it stand for?
(1) colon
(2) coelom
(3) coenzyme
(4) coli

2011

100. Agarose extracted from sea weeds is used in
(1) spectrophotometry
(2) tissue culture
(3) PCR
(4) gel electrophoresis.

2010

101. Which of the following are used in gene cloning?
(1) Nucleoids
(2) Lomasomes
(3) Mesosomes
(4) Plasmids

2010

102. Which one of the following palindromic base sequences in DNA can be easily cut at about the middle by some particular restriction enzyme?
(1) 5'___CGTTCG___3'
3'___ATGGTA___5'
(2) 5'___GATATG___3'
3'___CTACTA___5'
(3) 5'___GAATTC___3'
3'___CTTAAG___5'
(4) 5'___CACGTA___3'
3'___CTCAGT___5'

2010

103. Which one of the following is used as vector for cloning genes into higher organisms?
(1) Baculovirus
(2) Salmonella typhimurium
(3) Rhizopus nigricans
(4) Retrovirus

2010

104. DNA or RNA segment tagged with a radioactive molecule is called
(1) vector
(2) probe
(3) clone
(4) plasmid.

2010

105. Restriction endonucleases are enzymes which
(1) make cuts at specific positions within the DNA molecule
(2) recognize a specific nucleotide sequence for binding of DNA ligase
(3) restrict the action of the enzyme DNA polymerase
(4) remove nucleotides from the ends of the DNA molecule.

Mains 2010

106. In genetic engineering, a DNA segment (gene) of interest, is transferred to the host cell through a vector. Consider the following four agents (i-iv) in this regard and select the correct option

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1996

131. When scientists make an animal superior by view of genotype, introducing some foreign genes in it, is called
(1) immunization
(2) genetic engineering
(3) tissue culture
(4) biotechnology.

1995

132. The restriction enzymes are used in genetic engineering, because
(1) they can cut DNA at specific base sequence
(2) they are nucleases that cut DNA at variable sites
(3) they can degrade harmful proteins
(4) they can join different DNA fragments.

1994

133. Which of the following organelles is related with genetic engineering?
(1) Mitochondria
(2) Plasmids
(3) Golgi bodies
(4) Lysosomes

NODIA

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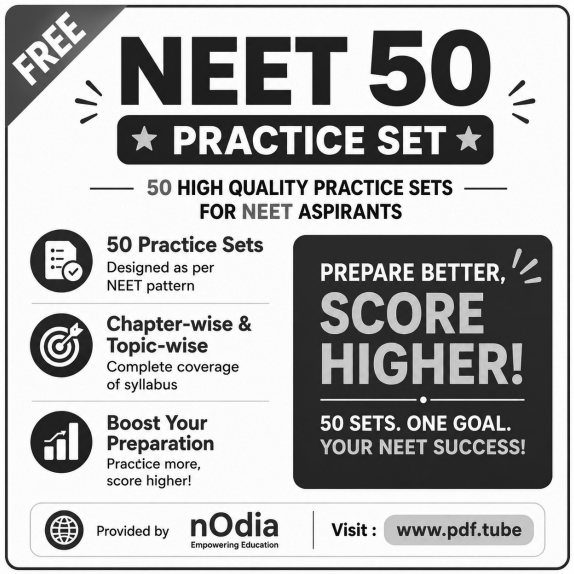

ANSWERS

1. (3) Both A and R are correct and R is the correct explanation of A
Lysozyme digests bacterial cell walls and cellulase breaks down plant cell walls, so A is correct. Isolation of DNA requires breaking open cells to release genetic material (R correct). Since cell disruption is the reason these enzymes are used, R explains A.

2. (3) Both Statement I and Statement II are correct
Plasmids are small, circular DNA molecules that replicate independently of chromosomal DNA, so Statement I is correct. They also exist separately from the bacterial chromosome, making them extrachromosomal, so Statement II is correct.

3. (1) annealing
In PCR, the annealing step occurs after denaturation. During annealing, the temperature is lowered so the two primers bind to their complementary sequences on the single-stranded DNA templates.

4. (3) A-II, B-I, C-IV, D-III
Transformation is transfer of DNA into host bacteria (II). The cloning site is where restriction enzymes cut to insert foreign DNA (I). Selection uses antibiotic resistance markers (IV). Ori is the origin of replication (III).

5. (1) A-II, B-III, C-I, D-IV
Bt cotton is a genetically modified organism. Thermostable Taq DNA polymerase is obtained from Thermus aquaticus. The Ti plasmid is found in Agrobacterium tumefaciens, used as a vector. pBR322 is a cloning vector derived from and maintained in Escherichia coli.

6. (4) Denaturation → Annealing → Extension
Each PCR cycle has three steps. Denaturation separates the double-stranded DNA into single strands at high temperature. Annealing allows primers to bind to complementary sequences. Extension lets Taq DNA polymerase synthesise new strands. This sequence repeats to amplify the target DNA exponentially.

7. (3) A, E, C, B, D
DNA fingerprinting begins with isolation and restriction digestion of DNA (A), followed by separation of fragments by electrophoresis (E). Fragments are then transferred (blotted) to a synthetic membrane (C), hybridised with a labelled VNTR probe (B), and finally detected through autoradiography (D), giving the order A, E, C, B, D.

8. (1) D, A, B, C, E
Somatic hybridisation begins with isolating single cells from two plant varieties (D), digesting their cell walls (A), and obtaining naked protoplasts (B). These protoplasts are fused to form a hybrid protoplast (C), which is then grown into a new plant (E), giving the order D, A, B, C, E.

9. (4) C and D only
Restriction endonucleases do not cut exactly at the centre; they cut at specific positions slightly away from the centre of the palindrome, leaving sticky ends, so C is wrong. They are endonucleases that cut within the DNA, not exonucleases removing terminal nucleotides, so D is wrong.

10. (2) A and B only
DNA is cut by restriction enzymes called molecular scissors (A correct), and fragments separate by size during agarose gel electrophoresis (B correct). DNA cannot be seen without staining (C wrong). Stained DNA is viewed under UV light, not ordinary visible light (D wrong).

11. (3) Tetracycline
In pBR322, the BamHI restriction site lies within the tetracycline resistance gene (tetR). Insertion of foreign DNA at this site disrupts the gene through insertional inactivation, so recombinant cells lose tetracycline resistance while retaining ampicillin resistance, allowing selection of transformants.

12. (1) White color colonies will be selected.
Inserting alien DNA into a vector's coding sequence for an enzyme like beta-galactosidase causes insertional inactivation. This disruption prevents the enzyme from being produced.

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In the presence of a chromogenic substrate, colonies that have successfully incorporated the recombinant DNA will appear white, while those without the insert will turn blue. This visual method simplifies identifying successful clones.

13. (2) Statement I is incorrect but statement II is correct.
Recombinant colonies are identified by the inactivation of the enzyme beta-galactosidase due to the insertion of foreign DNA into the coding sequence. This process, known as insertional inactivation, prevents the formation of blue color in the presence of a chromogenic substrate. Therefore, white colonies represent recombinants, while blue colonies represent non-recombinants that still contain the original, uninterrupted plasmid.

14. (3) C and D only
Basic gene cloning requires restriction enzymes for cutting DNA, DNA ligase for joining fragments, and DNA polymerase for replication. Enzymes such as DNA mutase and DNA recombinase are not fundamental requirements for the standard cloning process. Mutase is involved in specific mutations, and recombinase handles genetic recombination, neither of which is essential for the basic process of gene insertion.

15. (3) Both statement I and statement II are correct.
DNA fragments separated during gel electrophoresis can be extracted from the agarose gel through a process called elution. These purified fragments are subsequently used to construct recombinant DNA molecules. During electrophoresis, negatively charged DNA moves toward the positive anode. Smaller fragments experience less resistance from the gel matrix, allowing them to travel faster and farther than the larger fragments.

16. (4) 2^n
The polymerase chain reaction involves repeated cycles of denaturation, annealing, and extension to amplify a specific DNA segment. Each cycle theoretically doubles the amount of target DNA present in the reaction. Consequently, after a specific number of cycles, the total number of DNA copies produced follows an exponential growth pattern represented by the mathematical formula of two raised to power n.

17. (4) B
In a stirred-tank bioreactor, several components work together to maintain optimal growth conditions for microorganisms. The foam breaker is a specific part designed to manage the layer of foam that naturally forms on the surface of the culture medium during vigorous stirring and aeration. Controlling this foam is crucial to prevent vessel overflow and maintain efficient gas exchange processes.

18. (3) B and C only
A piece of DNA lacking an origin of replication cannot multiply independently within a host cell. However, if this alien DNA integrates into the host organism's genome, it becomes part of a larger chromosome that possesses its own origin of replication. In this state, the foreign DNA will be replicated and inherited along with the host's genetic material.

19. (4) ori site.
The origin of replication is a specific sequence of nucleotides in a chromosome or plasmid where the replication process begins. Any DNA fragment linked to this sequence can be replicated within the host cell. This site also plays a critical role in controlling the number of copies of the linked DNA that are produced and maintained by the cell.

20. (1) Separated DNA fragments can be directly seen under UV radiation.
DNA fragments are naturally colorless and cannot be seen directly under normal light or ultraviolet radiation. To visualize the separated bands, the DNA must first be stained with a fluorescent dye such as ethidium bromide. Once stained, the DNA fragments emit a bright orange light when exposed to ultraviolet radiation, allowing researchers to identify and extract the specific segments.

21. (1) Hind II, Hind II
Creating a recombinant DNA molecule typically requires cutting both the vector DNA and the source DNA with the same restriction enzyme. Using the same enzyme ensures that the resulting fragments have compatible ends, whether they are blunt or sticky. This compatibility allows the DNA ligase enzyme to efficiently join the foreign DNA segment to the vector plasmid backbone.

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2002

118. Manipulation of DNA in genetic engineering became possible due to the discovery of
(1) restriction endonuclease
(2) DNA ligase
(3) transcriptase
(4) primase.

2002

119. Which of the following enzymes are used to join bits of DNA?
(1) Ligase
(2) Primase
(3) DNA polymerase
(4) Endonuclease

2001

120. A mutant strain of T4 - Bacteriophage, R-II, fails to lyse the E. coli but when two strains R-IIX and R-IIY are mixed then they lyse the E. coli. What may be the possible reason?
(1) Bacteriophage transforms in wild.
(2) It is not mutated.
(3) Both strains have similar cistrons.
(4) Both strains have different cistrons.

2001

121. Which of the following cut the DNA from specific places?
(1) E.coli restriction endonuclease I
(2) Ligase
(3) Exonuclease
(4) Alkaline phosphate

2001

122. Maximum number of bases in plasmids discovered so far
(1) 50 kilo base
(2) 500 kilo base
(3) 5000 kilo base
(4) 5 kilo base.

2000

123. The bacteria generally used for genetic engineering is
(1) Agrobacterium
(2) Bacillus
(3) Pseudomonas
(4) Clostridium.

2000

124. Plasmid has been used as vector because
(1) it is circular DNA which have capacity to join to eukaryotic DNA
(2) it can move between prokaryotic and eukaryotic cells
(3) both ends show replication
(4) it has antibiotic resistance gene.

1999

125. Which of the following is related to genetic engineering?
(1) Heterosis
(2) Mutation
(3) Plastid
(4) Plasmid

1999

126. The process of replication in plasmid DNA, other than initiation, is controlled by
(1) mitochondrial gene
(2) plasmid gene
(3) bacterial gene
(4) none of these.

1998

127. Genetic engineering is possible, because
(1) we can cut DNA at specific sites by endonucleases like DNase I
(2) restriction endonucleases purified from bacteria can be used in vitro
(3) the phenomenon of transduction in bacteria is well understood
(4) we can see DNA by electron microscope.

1998

128. Recombinant DNA is achieved by cleaving the pro-DNAs by
(1) ligase
(2) restriction endonuclease
(3) primase
(4) exonucleases.

1998

129. Two bacteria found to be very useful in genetic engineering experiments are
(1) Nitrobacter and Azotobacter
(2) Rhizobium and Diplococcus
(3) Nitrosomonas and Klebsiella
(4) Escherichia and Agrobacterium.

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1998

130. Restriction endonucleases are
(1) used for in vitro DNA synthesis
(2) used in genetic engineering
(3) synthesized by bacteria
(4) present in mammalian cells for degradation of DNA.

31. (1) It is used to deliver gene of interest in both prokaryotic as well as eukaryotic host cells.
Agrobacterium tumefaciens is a soil-borne bacterium primarily known for its ability to naturally transform plant cells, which are eukaryotic. It uses its Ti plasmid to deliver a specific DNA segment, called T-DNA, into the plant genome. While it is a powerful tool for plant genetic engineering, it is not used as a universal vector for delivering genes into prokaryotic hosts.

32. (3) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)
In genetic engineering, Kanamycin is an antibiotic, while the Kanamycin resistance gene serves as a selectable marker to identify transformants. Cla I is a specific restriction endonuclease recognition site found on various plasmids. Disarmed retroviruses are commonly employed as vectors to deliver foreign genes into animal cells without causing disease, leveraging their natural ability to integrate DNA into host genomes.

33. (2) bright orange colour
Ethidium bromide is a fluorescent dye that intercalates between the base pairs of DNA. When DNA fragments stained with this dye are exposed to ultraviolet radiation, they fluoresce and appear as distinct, bright orange bands. This visualization technique is essential in gel electrophoresis for identifying the presence, size, and quantity of DNA fragments after they have been separated by size.

34. (1) tungsten or gold
The gene gun, or biolistic method, is a technique used to introduce foreign DNA into host cells, particularly plant cells. In this process, microscopic particles made of heavy metals like gold or tungsten are coated with the desired DNA. These microparticles are then accelerated at high velocities into the target tissue, allowing the DNA to enter and integrate into the cells.

35. (2) Probe
A cloning vector is a DNA molecule used to carry foreign genetic material into another cell. Examples include plasmids like pBR322, bacterial artificial chromosomes, and yeast artificial chromosomes. In contrast, a probe is a single-stranded DNA or RNA fragment tagged with a radioactive or fluorescent marker. Probes are used to detect specific complementary sequences in a sample, not for cloning.

36. (1) Thermus aquaticus
The polymerase chain reaction requires a DNA polymerase that can withstand the high temperatures used during the denaturation step. Taq polymerase is a thermostable enzyme isolated from the bacterium Thermus aquaticus, which thrives in extreme heat environments like hot springs. This heat stability allows the enzyme to remain functional throughout multiple cycles of heating and cooling in the PCR process.

37. (1) C, B, D, A
The formation of recombinant DNA involves several sequential steps. First, the desired DNA fragment is isolated from the source organism. This is followed by cutting the DNA at specific locations using restriction enzymes to obtain the gene of interest. Next, this gene is amplified using PCR to produce many copies. Finally, the recombinant DNA is inserted into a suitable host cell.

38. (4) DNA.
During the isolation and purification of nucleic acids, various enzymes are used to remove proteins, RNA, and other cellular components. Once these contaminants are degraded or removed, the addition of chilled ethanol to the solution causes the purified DNA to precipitate. The DNA then appears as a collection of fine threads that can be easily collected through a process known as spooling.

39. (3) The presence of chromogenic substrate gives blue coloured DNA bands on the gel.
Gel electrophoresis relies on fluorescent staining, typically using ethidium bromide, to visualize DNA fragments under ultraviolet light. It does not use chromogenic substrates to produce colored bands on the gel. Chromogenic substrates are more commonly used in colony screening methods, such as blue-white selection, to identify recombinant bacteria based on enzyme activity rather than for visualizing separated DNA fragments.

40. (2) 5' G A A T T C 3' ; 3' C T T A A G 5'
Restriction enzymes recognize specific palindromic sequences where the nucleotide arrangement reads the same on both strands in the 5' to 3' direction. The sequence GAATTC is a classic example of such a palindrome, recognized by the enzyme EcoRI. When the enzyme encounters this sequence, it cuts the DNA at

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a precise location, facilitating the creation of recombinant DNA molecules.

41. (1) Both Statement I and Statement II are correct.
Restriction endonucleases function by recognizing specific palindromic sequences in DNA. These enzymes typically cut the two strands of the double helix at a point slightly removed from the center of the palindromic site, but between the same two bases on opposite strands. This staggered cutting pattern creates overhanging single-stranded ends, which are very useful for joining different DNA fragments together.

42. (4) Presence of two or more recognition sites
An ideal cloning vector should have only a single recognition site for a particular restriction enzyme. Having multiple recognition sites for the same enzyme would result in the vector being cut into several small fragments. This fragmentation complicates the cloning process and makes it much more difficult to successfully integrate and maintain the foreign DNA segment within the host cell.

43. (2) Both (A) and (R) are correct but (R) is not the correct explanation of (A).
Polymerase chain reaction is a vital laboratory technique used to amplify specific DNA sequences millions of times. Separately, antibiotic resistance genes like the ampicillin resistance gene are used as selectable markers in cloning experiments. These markers allow researchers to distinguish between cells that have successfully taken up a plasmid and those that have not, although this process is unrelated to PCR.

44. (3) bright orange bands
Visualizing DNA fragments after gel electrophoresis requires staining them with a specific dye, most commonly ethidium bromide. This dye binds to the DNA and fluoresces when exposed to ultraviolet light. As a result, the separated DNA fragments appear as distinct, bright orange bands against the background of the gel, allowing researchers to accurately determine their size and position after separation.

45. (2) It will not be able to confer ampicillin resistance to the host cell.
If a foreign gene is inserted into the PstI restriction site located within the ampicillin resistance gene of pBR322, the gene's coding sequence is interrupted. This leads to insertional inactivation, meaning the plasmid can no longer produce the protein required for ampicillin resistance. Consequently, host cells containing this recombinant plasmid will fail to grow on medium supplemented with the antibiotic ampicillin.

46. (4) palindromic nucleotide sequences.
Restriction endonucleases are highly specific enzymes that identify and bind to particular arrangements of nucleotides known as palindromic sequences. In these sequences, the order of bases is identical on both DNA strands when read in the same direction, such as 5' to 3'. By recognizing these patterns, the enzymes can make precise cuts at defined positions within the DNA molecule.

47. (2) Denaturation, Annealing, Extension
The polymerase chain reaction consists of three main steps performed in a specific order. First, denaturation uses high heat to separate the double-stranded DNA into single strands. Second, annealing involves lowering the temperature to allow primers to bind to their target sequences. Third, extension occurs as a heat-stable DNA polymerase synthesizes new DNA strands by adding nucleotides to the primers.

48. (3) DNA
In the final stages of purifying DNA for genetic engineering, various enzymes are employed to remove cellular contaminants like proteins and RNA. After these steps, the addition of chilled ethanol causes the purified DNA to come out of the solution. This precipitated DNA appears as fine, white threads that can be collected for use in downstream applications like cloning or sequencing.

49. (4) Purification of isolated protein
Polymerase chain reaction is primarily a tool for DNA manipulation, used for tasks such as gene amplification, molecular diagnosis of diseases, and detecting genetic mutations. While it is extremely effective at producing many copies of a DNA segment, it is not used for the purification of proteins. Protein purification involves entirely different biochemical techniques like chromatography, which focus on separating proteins.

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50. (4) Denaturation
The first step of any PCR cycle is denaturation, which requires heating the reaction mixture to approximately ninety-four degrees Celsius. This high temperature is necessary to break the hydrogen bonds between the complementary base pairs, thereby separating the double-stranded DNA into two single strands. If this temperature is not reached, the strands will remain joined, preventing the subsequent steps of annealing.

51. (1) Each restriction enzyme functions by inspecting the length of a DNA sequence.
Restriction enzymes do not function by measuring the total length of a DNA molecule. Instead, they operate by scanning the DNA for specific, short nucleotide sequences known as recognition sites. Once an enzyme identifies its specific sequence, it binds to the DNA and cuts each of the two strands of the double helix at precise locations within or near that specific site.

52. (1) Ligases - Join the two DNA molecules
DNA ligase is an essential enzyme in molecular biology that functions like glue, joining together DNA fragments by catalyzing the formation of phosphodiester bonds. Other enzymes have different roles: polymerases synthesize new DNA strands, nucleases break down nucleic acids, and restriction endonucleases make cuts at specific internal sites. Correctly identifying these enzymatic functions is fundamental to understanding and performing genetic engineering.

53. (1) 5' - GAATTC - 3'
The restriction endonuclease EcoRI specifically recognizes a six-base pair palindromic sequence. This sequence consists of the bases GAATTC on one strand and its complementary sequence CTTAAG on the opposite strand. When both are read in the five-prime to three-prime direction, they are identical. The enzyme cuts this sequence between the guanine and adenine bases, creating useful overhanging sticky ends.

54. (2) Ori site
The origin of replication, often abbreviated as ori, is a specific DNA sequence in a vector where replication is initiated. Beyond simply starting the process, the ori site is also responsible for controlling the copy number of the plasmid or linked DNA within the host cell. Selecting a vector with a high-copy-number ori is often desirable for producing large amounts of a specific gene.

55. (2) ethidium bromide in UV radiation
To see DNA fragments after they have been separated by size during gel electrophoresis, the gel must be treated with a fluorescent stain. Ethidium bromide is the most common choice because it binds strongly to DNA. When the stained gel is placed under ultraviolet radiation, the DNA fragments fluoresce, appearing as bright orange bands that can be easily documented and analyzed.

56. (2) (iv) (iii) (i) (ii)
Bacillus thuringiensis is well known for producing Cry proteins, which are used as bio-insecticides. Thermus aquaticus is the source of the heat-stable Taq DNA polymerase used in PCR. Agrobacterium tumefaciens is a natural genetic engineer used as a cloning vector for plants. Salmonella typhimurium provided the plasmid used to construct the very first recombinant DNA molecule by laboratory researchers.

57. (3) The enzyme binds DNA at specific sites and cuts only one of the two strands.
Restriction endonucleases are enzymes that function by inspecting the length of a DNA sequence. Once they find a specific recognition sequence, they bind to the DNA and cut each of the two strands of the double helix. This dual cutting occurs at specific points in the sugar-phosphate backbones, often resulting in either blunt ends or useful overhanging sticky ends.

58. (1) help in eliminating the non-transformants, so that the transformants can be regenerated
In genetic transformation experiments, only a small fraction of host cells successfully take up the foreign DNA. A selectable marker is a gene included in the vector that allows researchers to distinguish between successful transformants and non-transformants. By applying a specific selection pressure, such as an antibiotic, only the cells containing the marker will survive and grow during the experiment.

59. (4) (i), (ii) and (iv)
DNA is a negatively charged molecule, so it is loaded at the negative cathode and moves toward the positive anode. The concentration of agarose in the gel directly affects the movement of DNA fragments by creating a sieving effect.

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fragment to be cloned. Plasmids are small, circular DNA molecules that are ideal for cloning relatively small segments of DNA. For larger fragments, researchers use specialized vectors with higher carrying capacities, such as cosmids, bacterial artificial chromosomes, or yeast artificial chromosomes, which accommodate longer sequences.

80. (2) BAC and YAC
Sequencing a complex genome like that of humans requires the cloning of very large fragments of DNA. Standard plasmids are too small for this task. Instead, researchers use specialized large-capacity vectors like Bacterial Artificial Chromosomes and Yeast Artificial Chromosomes. These vectors can carry hundreds of thousands of base pairs, allowing for the construction of genomic libraries and chromosome mapping.

81. (4) PCR.
Southern hybridization is a classical laboratory technique used to detect specific DNA sequences within a large sample. The process involves several steps: separating DNA fragments by gel electrophoresis, transferring those fragments onto a membrane, and then using a radioactive probe to identify the target sequence through autoradiography. While PCR also manipulates DNA, it is not a required component of this procedure.

82. (1) PCR and RAPD
Clonal propagation in plants involves producing genetically identical offspring from a single parent. In laboratory settings, techniques like the polymerase chain reaction and Random Amplified Polymorphic DNA are often used to assess and ensure genetic uniformity among the clones. These molecular markers help researchers verify that no unwanted genetic variation has occurred during the tissue culture or propagation process during research.

83. (3) non-recombinant bacteria containing beta galactosidase
The blue-white screening method uses the enzyme beta-galactosidase to differentiate between recombinant and non-recombinant bacteria. Non-recombinant bacteria possess a functional enzyme that breaks down a chromogenic substrate to produce a blue color. In recombinants, the insertion of foreign DNA disrupts the gene for this enzyme, leading to insertional inactivation. Consequently, these bacteria cannot produce the blue color and form white colonies.

84. (1) electrophoresis
After DNA has been cut into various fragments by restriction endonucleases, the pieces can be separated according to their size using a technique called gel electrophoresis. An electric field is applied across a gel matrix, causing the negatively charged DNA fragments to migrate toward the positive anode. Smaller fragments move faster and farther than larger ones, creating a clear pattern of bands.

85. (1) Algae - Methylase
To isolate DNA from different organisms, their cell walls must first be broken down using specific enzymes. Lysozyme is used for bacteria, chitinase for fungi, and cellulase for plant cells. However, methylase is not a cell-wall-degrading enzyme; it is an enzyme involved in adding methyl groups to DNA. Algal cell walls are typically degraded using enzymes like cellulase or other enzymes.

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86. (1) precipitate DNA
In the process of DNA isolation, cellular components are first broken down and proteins are removed. Once a clean aqueous solution of DNA remains, chilled ethanol is added. Because DNA is insoluble in cold alcohol, it precipitates out of the solution. This allows the DNA to be seen as fine, white threads that can then be easily collected and purified.

87. (2) Vector DNA - Site for tRNA synthesis
Vector DNA is a tool used in genetic engineering to carry and replicate foreign genes in a host cell; it is not a specialized site for the synthesis of transfer RNA. Other biological terms like somatic hybridization, micropropagation, and callus are correctly associated with their respective processes of cell fusion, large-scale plant production, and the formation of masses of cells.

88. (4) ampR, tetR-antibiotic resistance genes
The pBR322 plasmid is a well-characterized cloning vector that contains several important features. These include an origin of replication, a rop gene, and two primary antibiotic resistance genes: ampR, which confers resistance to ampicillin, and tetR, which confers resistance to tetracycline. These genes serve as essential

ends. DNA ligase facilitates the formation of phosphodiester bonds between these fragments, effectively sealing them together to create a single recombinant molecule.

70. (2) EcoRV
While many restriction endonucleases cut DNA asymmetrically to create overhanging sticky ends, some enzymes cut straight across both strands of the double helix. EcoRV is a well-known example of an enzyme that produces such blunt ends. These ends do not have overhanging bases, which can be useful in certain cloning strategies where simple, direct joining of DNA fragments is required.

71. (2) Single-stranded
Plasmids are naturally occurring DNA molecules found in many bacteria. They are characterized by several key features: they are extra-chromosomal, meaning they exist separately from the main genomic DNA; they have a circular structure; they are double-stranded; and they possess their own origin of replication, allowing them to replicate independently within the host cell and be transferred easily between different bacteria.

72. (3) Hind II
Restriction endonucleases are specialized enzymes that cut DNA at specific recognition sequences. Hind II was the very first such enzyme to be isolated and characterized. Unlike general nucleases like DNase or RNase, which break down nucleic acids randomly, restriction enzymes like Hind II provide the precision necessary for genetic engineering by cutting DNA at highly predictable and specific locations.

73. (3) availability of oxygen throughout the process
Stirred-tank bioreactors are designed to facilitate the large-scale growth of cells by providing a controlled environment. A primary function of the stirring mechanism is to ensure that oxygen is evenly distributed and remains available to all the microorganisms throughout the entire culture vessel. This efficient aeration is critical for maintaining high rates of aerobic metabolism and maximizing product production.

74. (4) Expression
Downstream processing refers to the series of steps taken after the biosynthetic stage to prepare a biological product for commercial use. This includes the separation of cells from the medium, purification of the target molecule, and adding preservatives. In contrast, expression refers to the earlier biosynthetic stage where the host cells actually produce the protein from the inserted foreign gene.

75. (3) Thermus aquaticus
Taq polymerase is a heat-stable enzyme that is essential for the success of the polymerase chain reaction. It is naturally produced by the bacterium Thermus aquaticus, which is an extremophile found in hot springs. Because this enzyme can function at high temperatures without being denatured, it can survive the repeated heating cycles required to separate DNA strands during amplification.

76. (4) vector.
In gene cloning, a vector is a DNA molecule used as a vehicle to artificially carry foreign genetic material into another cell. Vectors are designed to be stable and are capable of autonomous replication within the host organism. Common examples include plasmids and bacteriophages. By integrating a gene of interest into a vector, researchers can ensure the gene is copied correctly.

77. (3) restriction enzymes
The field of genetic engineering was revolutionized by the discovery of restriction enzymes. These biological molecules act as precise scissors that can identify specific sequences of nucleotides and cut the DNA at those exact locations. This ability to cut DNA into predictable fragments allowed scientists to isolate specific genes and join them with other DNA molecules, forming the basis of technology.

78. (3) infection of the plant by Agrobacterium tumefaciens
The transfer of T-DNA into plant cells is a natural process carried out by the soil bacterium Agrobacterium tumefaciens. This bacterium possesses a Ti plasmid that contains the T-DNA segment. When the bacterium infects a plant, typically through a wound, it naturally transfers the T-DNA into the plant's cells. The T-DNA then integrates into the host's genome, redirecting cellular activity.

79. (3) Plasmid
Different types of vectors are used in genetic engineering depending on the size of the DNA

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118. (1) restriction endonuclease
The ability to manipulate DNA in a laboratory setting became possible with the discovery of restriction endonucleases. These enzymes act as biological scissors that cut DNA at specific, predictable sequences. This discovery gave researchers the tool they needed to break DNA into manageable pieces, isolate specific genes, and precisely recombine them with other DNA molecules, launching modern genetic engineering.

119. (1) Ligase
DNA ligase is the essential enzyme used in molecular biology to join DNA fragments together. It works by facilitating the formation of a phosphodiester bond between the three-prime hydroxyl group of one DNA fragment and the five-prime phosphate group of another. This sealing action is critical for creating stable recombinant DNA molecules, as it permanently links the foreign gene.

120. (4) Both strains have different cistrons.
In genetics, if two mutant strains that cannot perform a function individually can do so when combined, it indicates that the mutations are in different genes or cistrons. In the case of the T4 bacteriophage strains, each one provides the functional protein that the other lacks. This process, known as complementation, allows the mixed population to successfully lyse the host bacteria.

121. (1) E.coli restriction endonuclease I
Restriction endonucleases, such as those isolated from Escherichia coli, are specialized enzymes that recognize specific nucleotide sequences and cut the DNA at those defined positions. This specificity distinguishes them from other nucleases, like exonucleases which remove bases from the ends. The discovery of these site-specific enzymes was a critical milestone in the development of recombinant DNA technology and genetic research.

122. (2) 500 kilo base
Plasmids are extrachromosomal DNA molecules that can vary significantly in size. While many common cloning vectors are small, around a few kilobases, naturally occurring mega-plasmids can be quite large. Scientific studies have identified plasmids that contain as many as five hundred kilobases. These large plasmids often carry specialized genes, such as those involved in metabolic pathways or resistance to multiple antibiotics.

123. (1) Agrobacterium
Agrobacterium is a genus of bacteria that is widely used in genetic engineering, especially for plant transformation. It possesses a natural mechanism for transferring DNA into the host plant's genome via its Ti plasmid. By disarming this plasmid and inserting a gene of interest, scientists can leverage the bacterium's natural infection process to efficiently create transgenic plants with improved traits.

124. (1) it is circular DNA which have capacity to join to eukaryotic DNA
Plasmids are excellent vectors for genetic engineering because they are small, circular, and can be easily manipulated. Importantly, they can be engineered to carry foreign DNA segments, including those from eukaryotic organisms. Once a recombinant plasmid is formed, it can be introduced into a host cell where it replicates independently, ensuring that the inserted gene is maintained and expressed.

125. (4) Plasmid
Plasmids are circular, double-stranded DNA molecules found in bacteria that exist independently of the chromosomal DNA. They are a fundamental tool in genetic engineering because they can be used as vectors to transport and replicate foreign genes. By cutting and pasting DNA into a plasmid, researchers can create recombinant molecules that can be easily introduced into other cells for study.

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126. (3) bacterial gene
Although plasmids possess their own origin of replication and can replicate independently of the bacterial chromosome, they still rely on the host cell's machinery for the process. Most of the enzymes and proteins required for DNA synthesis, beyond the initial recognition of the ori site, are provided by the host's bacterial genes. This dependency ensures that plasmid replication is efficient.

127. (2) restriction endonucleases purified from bacteria can be used in vitro
The feasibility of genetic engineering rests on the availability of purified enzymes that can manipulate DNA outside of a living cell. Specifically, restriction endonucleases can be

selectable markers, allowing scientists to identify which host cells have successfully taken up the plasmid.

89. (4) probe.
A probe is a short, single-stranded segment of DNA or RNA that has been tagged with a radioactive or fluorescent label. In molecular biology, probes are used to detect the presence of complementary sequences in a complex mixture of nucleic acids. The probe binds to its target sequence through base pairing, and the label allows researchers to visualize the genetic material.

90. (4) gold or tungsten.
The gene gun, also known as the biolistic delivery system, is a direct method for transferring genes into cells. It works by coating microscopic particles of heavy, inert metals like gold or tungsten with the desired DNA fragments. These coated micro-particles are then physically fired into target tissues or cells at high speed, where the DNA can be successfully integrated.

91. (2) transformation of plant cells
Biolistics, or the gene gun method, is particularly suitable for the genetic transformation of plant cells. Because plant cells have a thick, rigid cell wall, they can be difficult to transform using conventional chemical methods. The biolistic approach bypasses this barrier by using high-pressure gas to shoot DNA-coated micro-particles directly into the plant tissue, allowing for successful gene delivery.

92. (1) as selectable markers
In cloning experiments, antibiotics are not typically used to treat infections but rather serve as selectable markers. By using a vector that contains an antibiotic resistance gene, researchers can grow the treated host cells on a medium containing that antibiotic. Only the cells that have successfully incorporated the vector will survive, providing an easy way to distinguish transformants from others.

93. (1) 5' - GAATTC - 3'
A palindromic sequence in DNA is a segment where the base pairs read the same in the 5' to 3' direction on both complementary strands. The sequence GAATTC is the specific recognition site for the restriction enzyme EcoRI. This symmetry is a common feature of the sites recognized by many restriction endonucleases, allowing the enzymes to bind precisely.

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94. (4) genetic fingerprinting.
PCR and Restriction Fragment Length Polymorphism are fundamental techniques used in genetic fingerprinting. These methods allow for the analysis of unique patterns in an individual's DNA. By amplifying specific regions and then cutting them with restriction enzymes, scientists can create a distinct profile that can be used for forensic identification, determining biological relationships, and studying genetic diversity within populations.

95. (4) It remains active at high temperature.
The polymerase chain reaction requires a specific type of DNA polymerase, most famously Taq polymerase, that can withstand extreme heat. During each cycle of PCR, the reaction is heated to near boiling temperatures to separate the DNA strands. Unlike typical enzymes that would be destroyed by this heat, Taq polymerase remains stable and active, allowing the reaction to proceed smoothly.

96. (3) C - extension in the presence of heat stable DNA polymerase
The polymerase chain reaction includes a final step in each cycle known as extension. During this phase, the temperature is optimized for a heat-stable DNA polymerase, like Taq polymerase, to synthesize new DNA strands. By adding deoxynucleotides to the primers, the enzyme creates complementary copies of the target sequence, resulting in the exponential growth of the genetic material.

97. (1) Recombinant DNA techniques
The ability to genetically engineer living organisms was made possible by the development of recombinant DNA techniques. These methods allow scientists to cut DNA from one source and join it with DNA from another, creating new genetic combinations. By introducing these hybrid molecules into host organisms, researchers can change their traits, produce valuable proteins, or study gene function precisely.

98. (4) Palindromic sequence of base pairs
The sequence GAATTC on one strand paired with CTTAAG on the other is a prime example of a palindromic sequence. In such a sequence, the order of nitrogenous bases is identical on

Additionally, pure DNA is invisible and cannot be seen directly under UV light without first being stained with a fluorescent dye.

60. (3) chilled ethanol
The extraction of pure DNA involves removing other cellular components using specific enzymes like proteases and ribonucleases. Once these impurities are handled, the addition of chilled ethanol to the mixture reduces the solubility of the DNA. This causes the DNA to precipitate out of the solution as fine, visible threads, which can then be collected by spooling onto a glass rod.

61. (1) Bioreactor
To produce biological products like enzymes or antibiotics on an industrial scale, microorganisms must be grown in large volumes. Bioreactors are specialized vessels that provide the optimal environment for this growth, including controlled temperature, pH, aeration, and nutrient supply. They allow for the processing of hundreds to thousands of liters of culture, far exceeding the capacity of standard laboratory equipment.

62. (1) Retrovirus
Retroviruses are specialized viruses that have the natural ability to infect animal cells and integrate their own genetic material into the host's genome. In biotechnology, these viruses can be disarmed by removing their harmful genes and replacing them with a gene of interest. This makes them highly effective vectors for delivering therapeutic genes into human cells, such as lymphocytes, during therapy.

63. (4) denaturation, annealing, extension.
The polymerase chain reaction follows a repeating three-step cycle to amplify DNA. It begins with denaturation, where high temperatures separate the two DNA strands. Next is annealing, where the reaction is cooled to allow primers to attach to their target sequences. Finally, extension occurs as a DNA polymerase enzyme synthesizes new strands by adding nucleotides, doubling the total amount of DNA.

64. (3) ethidium bromide
Because DNA fragments are naturally colorless, they must be stained to be seen after gel electrophoresis. Ethidium bromide is a fluorescent dye that binds to the DNA molecule. When the gel is subsequently exposed to ultraviolet radiation, the regions containing DNA fragments fluoresce and appear as bright orange bands, allowing researchers to see and analyze the final separation results.

65. (1) negatively charged
DNA molecules are fundamentally negatively charged due to the presence of phosphate groups in their sugar-phosphate backbone. This negative charge is consistent regardless of the fragment's length or sequence. In an electric field, such as the one used during gel electrophoresis, this property causes all DNA fragments to migrate away from the negative electrode and toward the positive anode.

66. (4) selectable marker.
A selectable marker is a specific gene included in a cloning vector that allows for the identification and selection of cells that have successfully undergone transformation. These markers usually confer a recognizable trait, such as resistance to an antibiotic like ampicillin or tetracycline. Cells that do not take up the vector will fail to survive when exposed to the agent.

67. (1) The smaller the fragment size, the farther it moves.
Gel electrophoresis separates DNA fragments based on their size through a sieving effect provided by the agarose matrix. When an electric field is applied, the negatively charged DNA moves toward the positive anode. Smaller fragments can navigate through the pores of the gel more easily and quickly than larger ones, resulting in them traveling a greater distance from the wells.

68. (1) downstream processing
After the biosynthetic stage where a product is formed in a bioreactor, it must undergo several steps before it is ready for the market. This stage is called downstream processing and includes the separation and purification of the desired protein or product. It also involves quality control testing and formulation with suitable preservatives to ensure the product remains safe for use.

69. (4) ligase.
DNA ligase is a crucial enzyme in genetic engineering that acts as molecular glue. When two DNA fragments, such as a gene of interest and a plasmid vector, have been cut with the same restriction enzyme, they possess compatible

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alters the permeability of the cell membrane, facilitating the uptake of the naked DNA. It is a common technique used for transforming plant cells.

109. (2) Agrobacterium tumefaciens
Agrobacterium tumefaciens is a soil bacterium often referred to as nature's genetic engineer. It has the natural ability to transfer a portion of its DNA, known as T-DNA, into the genome of plants. By modifying the bacterium's Ti plasmid to carry a gene of interest instead of its original genes, researchers can effectively use Agrobacterium to create transgenic crop plants.

110. (4) separation of DNA fragments according to their size.
Gel electrophoresis is a standard laboratory technique used to separate a mixture of DNA fragments. When an electric current is applied, the negatively charged DNA molecules migrate through an agarose gel toward the positive electrode. The gel acts as a molecular sieve, allowing smaller fragments to move more quickly than larger ones, which effectively separates the fragments based on their length.

111. (3) DNA ligase.
The construction of recombinant DNA molecules involves two main enzymatic steps. First, restriction endonucleases are used to cut the DNA at specific sites. Second, DNA ligase is used to join the fragments together. This enzyme catalyzes the formation of chemical bonds between the ends of the DNA strands, allowing a gene, such as one for antibiotic resistance, to be linked.

112. (3) cuts the DNA molecule at specific sites
Restriction endonucleases are highly specific enzymes that recognize and bind to particular sequences of nucleotides in a DNA molecule. Once the enzyme identifies its target sequence, it cuts the double-stranded DNA at precise locations within or near that site. This ability to make predictable and consistent cuts is what makes these enzymes essential for genome mapping and recombinant DNA.

113. (2) Escherichia coli and Agrobacterium tumefaciens
Two of the most important microorganisms in the field of genetic engineering are Escherichia coli and Agrobacterium tumefaciens. E. coli is widely used as a host for cloning and producing proteins because it is well-understood and grows rapidly. Agrobacterium tumefaciens is indispensable for plant biotechnology because of its natural ability to transfer DNA into plant cells for creating transgenic crops.

114. (4) are synthesized by bacteria as part of their defense mechanism.
Restriction endonucleases are naturally produced by many species of bacteria. Their biological function is to serve as a primitive immune system or defense mechanism against invading viruses, such as bacteriophages. These enzymes recognize and cut up the foreign viral DNA, thereby restricting the infection. In biotechnology, these purified enzymes are harnessed for their ability to precisely cut DNA at specific sequences.

115. (3) Agrobacterium
The Ti plasmid, or tumor-inducing plasmid, is a large extrachromosomal DNA molecule found in the bacterium Agrobacterium tumefaciens. This plasmid is the key component that allows the bacterium to genetically transform plant cells. Because it can naturally integrate DNA into the host plant's genome, the Ti plasmid has been extensively modified by scientists for use as a vector for plants.

116. (2) gall formation on certain angiosperms by Agrobacterium
One of the most thoroughly investigated interactions between bacteria and plants is the formation of crown galls caused by Agrobacterium tumefaciens. This bacterium transfers a specific segment of its DNA into the host plant's genome, triggering uncontrolled cell division and the production of nutrients for the bacteria. Understanding this natural genetic transfer was a foundational step in modern plant biotechnology.

NODIA

117. (4) Agrobacterium tumefaciens
Agrobacterium tumefaciens is the primary bacterium used for genetic engineering in plants. Its utility stems from its unique ability to infect plants and deliver a specific DNA segment, the T-DNA, into the host cell's nucleus, where it integrates into the genome. By replacing the natural T-DNA genes with a gene of interest, researchers can create a wide variety of plants.

both strands when read in the five-prime to three-prime direction. This structural symmetry is specifically recognized by certain restriction enzymes, which bind at these sites to perform precise cuts.

99. (4) coli
The nomenclature for restriction enzymes follows a specific set of rules based on the organism from which they were isolated. In the name EcoRI, E stands for the genus Escherichia, and co stands for the species coli. The R indicates the specific strain, and the Roman numeral I signifies that it was the first enzyme to be isolated.

100. (4) gel electrophoresis.
Agarose is a natural polymer extracted from seaweed and is most commonly used in molecular biology for gel electrophoresis. When dissolved in a buffer and cooled, it forms a porous gel matrix. This matrix acts as a sieve that allows DNA fragments to be separated based on their size when an electric field is applied, making it an indispensable tool.

101. (4) Plasmids
Plasmids are small, circular, extra-chromosomal DNA molecules found naturally in bacteria. Because they can replicate independently of the host's genomic DNA and are easy to manipulate, they are widely used as vectors in gene cloning. Researchers can insert a target gene into a plasmid and then introduce the plasmid into a bacterium to produce many copies of that gene.

102. (3) 5' GAATTC 3'
Restriction enzymes target specific sequences where the nucleotide arrangement is symmetrical across both strands. The GAATTC sequence is recognized by the enzyme EcoRI. While some enzymes cut exactly in the middle to produce blunt ends, EcoRI cuts slightly off-center to produce sticky ends. The presence of a clear palindrome is what defines these specific recognition and cleavage sites.

103. (4) Retrovirus
In biotechnology, retroviruses are commonly used as vectors for introducing foreign genes into higher organisms, particularly animal cells. These viruses have a natural mechanism for integrating their genetic material into the host cell's genome. By disarming the virus and replacing its disease-causing genes with a gene of interest, researchers can safely and effectively deliver new genetic information to the host.

104. (2) probe
A probe is a short segment of single-stranded DNA or RNA that has been modified with a radioactive or fluorescent tag. Probes are essential tools for identifying specific genetic sequences within a larger sample. They work by binding to their complementary base sequence through hybridization, and the attached label allows scientists to detect and track the target gene's location.

105. (1) make cuts at specific positions within the DNA molecule
Restriction endonucleases are a class of enzymes that provide high precision in genetic engineering. They function by identifying specific sequences of nucleotides, known as recognition sites, within a DNA molecule. Once the enzyme binds to its specific site, it cuts the sugar-phosphate backbone of both strands of the DNA double helix at defined locations, producing fragments for cloning.

106. (4) (ii) and (iv)
In the context of genetic engineering, vectors are DNA molecules used to carry and replicate foreign genes in a host cell. Plasmids, which are small circular DNA molecules found in bacteria, and bacteriophages, which are viruses that infect bacteria, are both commonly used as vectors. Bacteria themselves are generally the host cells, while Plasmodium is a pathogen and not a vector.

107. (4) availability of oxygen throughout the process.
Stirred-tank bioreactors are engineered to support the growth of large-scale microbial or cell cultures. One of their most critical features is a stirring system that ensures the culture medium is well-mixed. This constant agitation helps to maintain a uniform temperature and nutrient concentration, and it also ensures that oxygen is efficiently dissolved and distributed throughout the vessel for growth.

108. (4) gene transfer without a vector.
Polyethylene glycol is a chemical used in direct gene transfer methods, which allow for the introduction of foreign DNA into host cells without the need for a biological vector like a plasmid or virus. This chemical treatment

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isolated from bacteria and used in laboratory settings to cut DNA at precise and predictable locations. This in vitro capability allows researchers to isolate, modify, and recombine genetic material from different sources before reintroducing it.

128. (2) restriction endonuclease
Recombinant DNA technology begins with the precise cleavage of donor and vector DNA molecules. This is achieved using restriction endonucleases, which are enzymes that recognize specific nucleotide sequences and cut the DNA strands at those points. This step is essential for creating the defined fragments that will later be joined together by DNA ligase to form the completed recombinant molecule.

129. (4) Escherichia and Agrobacterium.
In the laboratory, Escherichia coli and Agrobacterium tumefaciens are the two most commonly used bacteria for genetic engineering experiments. E. coli serves as the workhorse for DNA cloning and protein production due to its simple genetics and rapid growth. Agrobacterium tumefaciens is the primary tool for plant genetic engineering because of its natural ability to deliver DNA into plant genomes.

130. (2) used in genetic engineering
Restriction endonucleases are specialized enzymes that are primarily recognized for their role as essential tools in genetic engineering. They provide the ability to cut DNA at specific, known sequences, which is the foundational step for creating recombinant DNA. While they are naturally produced by bacteria as a defense mechanism, their importance in modern biotechnology stems from their widespread laboratory use.

131. (2) genetic engineering
Genetic engineering is the direct manipulation of an organism's genes using biotechnology. When scientists introduce foreign genetic material into an animal to improve its traits or change its genotype, they are performing a type of genetic engineering. This process allows for the creation of transgenic animals that can produce specific proteins or exhibit enhanced growth and resistance characteristics in farming.

132. (1) they can cut DNA at specific base sequence
The primary reason restriction enzymes are used in genetic engineering is their incredible specificity. Unlike other enzymes that might degrade DNA randomly, each restriction enzyme identifies a unique sequence of bases and cuts the DNA only at that site. This predictability allows scientists to consistently cut DNA into the same set of fragments, which is necessary for accurately mapping genes.

133. (2) Plasmids
Although often treated as vectors in biotechnology rather than traditional organelles, plasmids are the extrachromosomal DNA structures most closely associated with genetic engineering. Found naturally in bacteria, these small circular segments are manipulated to carry and clone foreign genes. Their independent replication and easy isolation make them the ideal vehicle for moving genetic information between different species in laboratory settings.

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(3) It is pest resistant, with a gene from Bacillus thuringiensis.
(4) It is drought tolerant, developed using Agrobacterium vector.

Odisha NEET 2019

34. In RNAi, the genes are silenced using
(1) ds-RNA
(2) ss-DNA
(3) ss-RNA
(4) ds-DNA.

2018

35. A 'new' variety of rice was patented by a foreign company, though such varieties have been present in India for a long time. This is related to
(1) Co-667
(2) Sharbati Sonora
(3) Lerma Rojo
(4) Basmati.

2018

36. In India, the organisation responsible for assessing the safety of introducing genetically modified organisms for public use is
(1) Indian Council of Medical Research (ICMR)
(2) Council for Scientific and Industrial Research (CSIR)
(3) Research Committee on Genetic Manipulation (RCGM)
(4) Genetic Engineering Appraisal Committee (GEAC).

2018

37. Use of bioresources by multinational companies and organisations without authorisation from the concerned country and its people is called
(1) bio-infringement
(2) biopiracy
(3) biodegradation
(4) bioexploitation.

NEET-I 2016

38. Which part of the tobacco plant is infected by Meloidogyne incognita?
(1) Stem
(2) Root
(3) Flower
(4) Leaf

NEET-II 2016

39. Which kind of therapy was given in 1990 to a four-year-old girl with adenosine deaminase (ADA) deficiency?
(1) Gene therapy
(2) Chemotherapy
(3) Immunotherapy
(4) Radiation therapy

NEET-I 2016

40. The two polypeptides of human insulin are linked together by
(1) covalent bond
(2) disulphide bridges
(3) hydrogen bonds
(4) phosphodiester bond.

2015

41. Golden rice is a genetically modified crop plant where the incorporated gene is meant for biosynthesis of
(1) omega 3
(2) vitamin A
(3) vitamin B
(4) vitamin C.

2015 Cancelled

42. In Bt cotton, the Bt toxin present in plant tissue as protoxin is converted into active toxin due to
(1) action of gut microorganisms
(2) presence of conversion factors in insect gut
(3) alkaline pH of the insect gut
(4) acidic pH of the insect gut.

2015 Cancelled

43. The crops engineered for glyphosate are resistant/ tolerant to
(1) insects (2) herbicides
(3) fungi (4) bacteria.

2015

44. A protoplast is a cell
(1) undergoing division
(2) without cell wall
(3) without plasma membrane
(4) without nucleus.

2015 Cancelled

45. A technique of micropropagation is
(1) protoplast fusion
(2) embryo rescue
(3) somatic hybridisation
(4) somatic embryogenesis.

2015 Cancelled

46. Which of the following enhances or induces fusion of protoplasts?
(1) IAA and kinetin
(2) IAA and gibberellins
(3) Sodium chloride and potassium chloride
(4) Polyethylene glycol and sodium nitrate

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Choose the correct sequence of steps from the options given below.
(1) E → C → B → A → D
(2) B → C → A → E → D
(3) A → E → B → D → C
(4) B → E → C → A → D

RE-EXAM 2024

10. Given below are two statements.
Statement I : RNA interference takes place in all eukaryotic organisms as method of cellular defense.
Statement II : RNAi involves the silencing of a specific mRNA due to a complementary single stranded RNA molecule that binds and prevents translation of mRNA.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

2024

11. Given below are two statements.
Statement I: Bt toxins are insect group specific and coded by a gene cryIAc.
Statement II: Bt toxin exists as inactive protoxin in B. thuringiensis. However, after ingestion by the insect the inactive protoxin gets converted into active form due to acidic pH of the insect gut.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are true.
(2) Both Statement I and Statement II are false.
(3) Statement I is true but Statement II is false.
(4) Statement I is false but Statement II is true.

2024

12. The capacity to generate a whole plant from any cell of the plant is called
(1) totipotency
(2) micropropagation
(3) differentiation
(4) somatic hybridisation.

2024

13. Which of the following are fused in somatic hybridisation involving two varieties of plants?
(1) Callus
(2) Somatic embryos
(3) Protoplasts
(4) Pollens

RE-EXAM 2024

14. Match List-I with List-II.

	List-I		List-II
A.	Genetically engineered human insulin	I	Gene therapy
B.	GM cotton	II	E.coli
C.	ADA deficiency	III	Antigen-antibody interaction
D.	ELISA	IV	Bacillus thuringiensis

Choose the correct answer from the options given below.
(1) A-III, B-II, C-IV, D-I
(2) A-II, B-I, C-IV, D-III
(3) A-IV, B-III, C-I, D-II
(4) A-II, B-IV, C-I, D-III

NODIA

2024

15. Match List I with List II :

	List-I		List-II
A.	α-1 antitrypsin	I	Cotton bollworm
B.	*CryIAb*	II	ADA deficiency
C.	*CryIAc*	III	Emphysema
D.	Enzyme replacement therapy	IV	Corn borer

Choose the correct answer from the options given below.
(1) A-II, B-I, C-IV, D-III
(2) A-III, B-I, C-II, D-IV
(3) A-III, B-IV, C-I, D-II
(4) A-II, B-IV, C-I, D-III

RE-EXAM 2024

16. Given below are two statements.
Statement I : The Indian Government has set up GEAC, which will make decisions regarding the validity of GM research.
Statement II : Biopiracy is the term used to refer to the use of bio-resources by native people.
In the light of the above statements, choose the correct answer from the options given below.
(1) Statement I is true but statement II is false.
(2) Statement I is false but statement II is true.
(3) Both statement I and statement II are true.
(4) Both statement I and statement II are false.

Manipur NEET 2023

17. Match List I with List II.

	List-I		List-II
A.	Gene therapy	I	Separation of DNA fragments
B.	RNA interference	II	Diagnostic test for AIDS
C.	ELISA	III	Cellular defence
D.	Gel Electrophoresis	IV	Allows correction of a gene defect

Choose the correct answer from the options given below.
(1) (A)-(IV), (B)-(I), (C)-(II), (D)-(III)
(2) (A)-(IV), (B)-(II), (C)-(III), (D)-(I)
(3) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)
(4) (A)-(IV), (B)-(III), (C)-(I), (D)-(II)

Manipur NEET 2023

18. Select incorrect statement regarding chemical structure of insulin.
(1) Mature insulin molecule consists of three polypeptide chains-A, B and C.
(2) Insulin is synthesised as prohormone which contains extra stretch of C-peptide.
(3) C-peptide is not present in mature insulin molecule.
(4) Polypeptide chains A and B are linked by disulphide bridges.

2023

19. Which one of the following techniques does not serve the purpose of early diagnosis of a disease for its early treatment?
(1) Polymerase Chain Reaction (PCR) technique
(2) Enzyme Linked Immuno-Sorbent Assay (ELISA) technique
(3) Recombinant DNA Technology
(4) Serum and Urine analysis

2022

20. Transposons can be used during which one of the following?
(1) Polymerase Chain Reaction
(2) Gene silencing
(3) Autoradiography
(4) Gene sequencing

2022

21. In gene therapy of Adenosine Deaminase (ADA) deficiency, the patient requires periodic infusion of genetically engineered lymphocytes because
(1) retroviral vector is introduced into these lymphocytes.
(2) gene isolated from marrow cells producing ADA is introduced into cells at embryonic stages
(3) lymphocytes from patient's blood are grown in culture, outside the body,
(4) genetically engineered lymphocytes are not immortal cells.

2022

22. Statements related to human insulin are given below.
Which statement(s) is/are correct about genetically engineered insulin ?
(A) Pro-hormone insulin contain extra stretch of C-peptide
(B) A-peptide and B-peptide chains of insulin were produced separately in E.coli, extracted and combined by creating disulphide bond between them.
(C) Insulin used for treating diabetes was extracted from cattle and pigs.
(D) Pro-hormone insulin needs to be processed for converting into a mature and functional hormone.
(E) Some patients develop allergic reactions to the foreign insulin.
Choose the most appropriate answer from the options given below:
(1) (A), (B) and (D) only
(2) (B) only
(3) (C) and (D) only
(4) (C), (D) and (E) only

2021

23. Match List-I with List-II.

	List-I		List-II
(p)	Protoplast fusion	(i)	Totipotency
(q)	Plant tissue culture	(ii)	Pomato
(r)	Meristem culture	(iii)	Somaclones
(s)	Micropropagation	(iv)	Virus free plants

Choose the correct answer from the options given below.
(1) (p)-(iv); (q)-(iii); (r)-(ii); (s)-(i)
(2) (p)-(iii); (q)-(iv); (r)-(ii); (s)-(i)
(3) (p)-(ii); (q)-(i); (r)-(iv); (s)-(iii)
(4) (p)-(iii); (q)-(iv); (r)-(i); (s)-(ii)

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2021

24. When gene targeting involving gene amplification is attempted in an individual's tissue to treat disease, it is known as
(1) safety testing
(2) biopiracy
(3) gene therapy
(4) molecular diagnosis.

2021

25. Now a days it is possible to detect the mutated gene causing cancer by allowing radioactive probe to hybridise its complimentary DNA in a clone of cells, followed by its detection using autoradiography because
(1) mutated gene does not appear on photographic film as the probe has complementarity with it
(2) mutated gene partially appears on a photographic film
(3) mutated gene completely and clearly appears on a photographic film
(4) mutated gene does not appear on a photographic film as the probe has no complementarity with it.

2021

26. For effective treatment of the disease, early diagnosis and understanding its pathophysiology is very important. Which of the following molecular diagnostic techniques is very useful for early detection?
(1) Hybridisation Technique
(2) Western Blotting Technique
(3) Southern Blotting Technique
(4) ELISA Technique

2021

27. With regard to insulin choose correct options.
(A) C-peptide is not present in mature insulin.
(B) The insulin produced by rDNA technology has C-peptide.
(C) The pro-insulin has C-peptide.
(D) A-peptide and B-peptide of insulin are interconnected by disulphide bridges.
Choose the correct answer from the options given below.
(1) (A) and (D) only
(2) (B) and (D) only
(3) (C) and (C) only
(4) (A), (C) and (D) only

2021

28. The Adenosine deaminase deficiency results into
(1) addison's disease
(2) dysfunction of immune system
(3) parkinson's disease
(4) digestive disorder.

2020

29. Bt cotton variety that was developed by the introduction of toxin gene of Bacillus thuringiensis (Bt) is resistant to
(1) insect pests
(2) fungal diseases
(3) plant nematodes
(4) insect predators.

2020

30. Match the following columns and select the correct option.

	Column I		Column II
A.	Bt cotton	(i)	Gene therapy
B.	Adenosine deaminase deficiency	(ii)	Cellular defence
C.	RNAi	(iii)	Detection of HIV infection
D.	PCR	(iv)	Bacillus thuringiensis

(1) (A)-(iv); (B)-(i); (B)-(ii); (B)-(iii)
(2) (A)-(iii); (B)-(ii); (B)-(i); (B)-(iv)
(3) (A)-(ii); (B)-(iii); (B)-(iv); (B)-(i)
(4) (A)-(i); (B)-(ii); (B)-(iii); (B)-(iv)

2020

31. Which of the following statements is not correct?
(1) In man insulin is synthesised as a proinsulin.
(2) The proinsulin has an extra peptide called C-peptide.
(3) The functional insulin has A and B chains linked together by hydrogen bonds.
(4) Genetically engineered insulin is produced in E.coli.

2019

32. What triggers activation of protoxin to active toxin of Bacillus thuringiensis in bollworm?
(1) Acidic pH of stomach
(2) Body temperature
(3) Moist surface of midgut
(4) Alkaline pH of gut

2019

33. Which of the following is true for Golden rice?
(1) It has yellow grains, because of a gene introduced from a primitive variety of rice.
(2) It is vitamin A enriched, with a gene from daffodil.

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2005

82. Golden rice is a transgenic crop of the future with the following improved trait
(1) insect resistance
(2) high lysine (essential amino acid) content
(3) high protein content
(4) high vitamin-A content.

2005

83. Production of a human protein in bacteria by genetic engineering is possible because
(1) the human chromosome can replicate in bacterial cell
(2) the mechanism of gene regulation is identical in humans and bacteria
(3) bacterial cell can carry out the RNA splicing reactions
(4) the genetic code is universal.

2004

84. The technique of obtaining large number of plantlets by tissue culture method is called
(1) plantlet culture
(2) organ culture
(3) micropropagation
(4) macropropagation.

2004, 2003

85. ELISA is used to detect viruses where the key reagent is
(1) alkaline phosphatase
(2) catalase
(3) DNA probe
(4) RNase.

2004

86. In transgenics, expression of transgene in target tissue is determined by
(1) enhancer (2) transgene
(3) promoter (4) reporter.

2003

87. Cellular totipotency is demonstrated by
(1) only gymnosperm cells
(2) all plant cells
(3) all eukaryotic cells
(4) only bacterial cells.

2003

88. Maximum application of animal cell culture technology today is in the production of
(1) insulin
(2) interferons
(3) vaccines
(4) edible proteins.

2002

89. In tissue culture medium, the embryoids formed from pollen grains is due to
(1) cellular totipotency
(2) organogenesis
(3) double fertilization
(4) test tube culture.

2000

90. Coconut milk is used in tissue culture in which present
(1) cytokinin (2) auxin
(3) gibberellin (4) ethylene.

1999

91. The first transgenic crop was
(1) tobacco (2) cotton
(3) pea (4) flax.

1999

92. The term 'humulin' is used for
(1) hydrolytic enzyme
(2) powerful antibiotic
(3) human insulin
(4) isoenzyme.

1999

93. Hybridoma cells are
(1) only cells having oncogenes
(2) product of spore formation in bacteria
(3) nervous cells of frog
(4) hybrid cells resulting from myeloma cells.

1995

94. The transgenic animals are those which have
(1) foreign RNA in all its cells
(2) foreign DNA in some of its cells
(3) foreign DNA in all its cells
(4) both (a) and (b).

1991

95. Cellular totipotency was demonstrated by
(1) Theodore Schwann
(2) A.V. Leeuwenhoek
(3) F.C. Steward
(4) Robert Hooke.

1990

96. Which ones produce androgenic haploids in anther cultures?
(1) Anther wall
(2) Tapetal layer of anther wall
(3) Connective tissue
(4) Young pollen grains

NODIA

2015 Cancelled

47. Which body of the Government of India regulates GM research and safety of introducing GM organisms for public services?
(1) Genetic Engineering Approval Committee
(2) Research Committee on Genetic Manipulation
(3) Bio-safety committee
(4) Indian Council of Agricultural Research

2014

48. To obtain virus - free healthy plants from a diseased one by tissue culture technique, which part/parts of the diseased plant will be taken?
(1) Apical meristem only
(2) Palisade parenchyma
(3) Both apical and axillary meristems
(4) Epidermis only

2014

49. The first human hormone produced by recombinant DNA technology is
(1) insulin
(2) estrogen
(3) thyroxin
(4) progesterone.

2013

50. Which of the following Bt crops is being grown in India by the farmers?
(1) Brinjal
(2) Soybean
(3) Maize
(4) Cotton

Karnataka NEET 2013

51. RNA interference involves
(1) synthesis of cDNA and RNA using reverse transcriptase
(2) silencing of specific mRNA due to complementary RNA
(3) interference of RNA in synthesis of DNA
(4) synthesis of mRNA from DNA.

Karnataka NEET 2013

52. Tissue culture technique can produce infinite number of new plants from a small parental tissue. The economic importance of the technique is in raising
(1) genetically uniform population identical to the original parent
(2) homozygous diploid plants
(3) new species
(4) variants through picking up somaclonal variations.

Karnataka NEET 2013

53. Which of the following statements is not true about somatic embryogenesis?
(1) The pattern of development of a somatic embryo is comparable to that of a zygotic embryo.
(2) Somatic embryos can develop from microspores.
(3) Somatic embryo is induced usually by an auxin such as 2, 4-D.
(4) A somatic embryo develops from a somatic cell.

Karnataka NEET 2013

54. Which one of the following vectors is used to replace the defective gene in gene therapy?
(1) Adenovirus
(2) Cosmid
(3) Ri plasmid
(4) Ti plasmid

2012

55. Consumption of which one of the following foods can prevent the kind of blindness associated with vitamin 'A' deficiency?
(1) 'Flavr Savr' tomato
(2) Canolla
(3) Golden rice
(4) Bt-Brinjal

Mains 2012

56. Tobacco plants resistant to a nematode have been developed by the introduction of DNA that produces (in the host cells)
(1) both sense and anti-sense RNA
(2) a particular hormone
(3) an antifeedant
(4) a toxic protein.

2012

57. Which part would be most suitable for raising virus-free plants for micropropagation ?
(1) Bark
(2) Vascular tissue
(3) Meristem
(4) Node

Mains 2012

58. The first clinical gene therapy was given for treating
(1) diabetes mellitus
(2) chicken pox
(3) rheumatoid arthritis
(4) adenosine deaminase deficiency.

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2011

59. The process of RNA interference (RNAi) has been used in the development of plants resistant to
(1) nematodes
(2) fungi
(3) viruses
(4) insects.

Mains 2011

60. Bacillus thuringiensis forms protein crystals which contain insecticidal protein. This protein
(1) binds with epithelial cells of midgut of the insect pest ultimately killing it
(2) is coded by several genes including the gene cry
(3) is activated by acid pH of the foregut of the insect pest
(4) does not kill the carrier bacterium which is itself resistant to this toxin.

Mains 2011

61. Silencing of mRNA has been used in producing transgenic plants resistant to
(1) boll worms
(2) nematodes
(3) white rusts
(4) bacterial blights.

2011

62. Maximum number of existing transgenic animals is of
(1) fish
(2) mice
(3) cow
(4) pig.

Mains 2011

63. Read the following four statements (A-D) about certain mistakes in two of them.
(A) The first transgenic buffalo, Rosie produced milk which was human alpha-lactalbumin enriched.
(B) Restriction enzymes are used in isolation of DNA from other macromolecules.
(C) Downstream processing is one of the steps of rDNA technology.
(D) Disarmed pathogen vectors are also used in transfer of rDNA into the host.
Which of the two statements have mistakes?
(1) B and C
(2) C and D
(3) A and C
(4) A and B

NODIA

2010

64. The genetically-modified (GM) brinjal in India has been developed for
(1) insect-resistance
(2) enhancing shelf life
(3) enhancing mineral content
(4) drought-resistance.

2010

65. Some of the characteristics of Bt cotton are
(1) long fibre and resistance to aphids
(2) medium yield, long fibre and resistance to beetle pests
(3) high yield and production of toxic protein crystals which kill dipteran pests
(4) high yield and resistance to bollworms.

2010

66. An improved variety of transgenic basmati rice
(1) does not require chemical fertilizers and growth hormones
(2) gives high yield and is rich in vitamin A
(3) is completely resistant to all insect pests and diseases of paddy
(4) gives high yield but has no characteristic aroma.

Mains 2010

67. Which one of the following is now being commercially produced by biotechnological procedures?
(1) Nicotine
(2) Morphine
(3) Quinine
(4) Insulin

2010

68. Genetic engineering has been successfully used for producing
(1) transgenic mice for testing safety of polio vaccine before use in humans
(2) transgenic models for studying new treatments for certain cardiac diseases
(3) transgenic cow-Rosie which produces high fat milk for making ghee
(4) animals like bulls for farm work as they have super power.

2009

69. What is true about Bt toxin?
(1) Bt protein exists as active toxin in the Bacillus.
(2) The activated toxin enters the ovaries of the pest to sterilise it and thus prevent its multiplication.

(3) The concerned Bacillus has antitoxins.
(4) The inactive protoxin gets converted into active form in the insect gut.

2009

70. Transgenic plants are the ones
(1) generated by introducing foreign DNA into a cell and regenerating a plant from that cell
(2) produced after protoplast fusion in artificial medium
(3) grown in artificial medium after hybridization in the field
(4) produced by a somatic embryo in artificial medium.

2009

71. The bacterium Bacillus thuringiensis is widely used in contemporary biology as
(1) insecticide
(2) agent for production of dairy products
(3) source of industrial enzyme
(4) indicator of water pollution.

2009

72. What is antisense technology?
(1) When a piece of RNA that is complementary in sequence is used to stop expression of a specific gene
(2) RNA polymerase producing DNA
(3) A cell displaying a foreign antigen used for synthesis of antigens
(4) Production of somaclonal variants in tissue cultures

2009

73. Somaclones are obtained by
(1) plant breeding
(2) irradiation
(3) genetic engineering
(4) tissue culture.

2009

74. The genetic defect-adenosine deaminase (ADA) deficiency may be cured permanently by
(1) administering adenosine deaminase activators
(2) introducing bone marrow cells producing ADA into cells at early embryonic stages
(3) enzyme replacement therapy
(4) periodic infusion of genetically engineered lymphocytes having functional ADA cDNA.

2008

75. Cry I endotoxins obtained from Bacillus thuringiensis are effective against
(1) nematodes
(2) bollworms
(3) mosquitoes
(4) flies.

2008

76. A transgenic food crop which may help in solving the problem of night blindness in developing countries is
(1) Bt soybean
(2) Golden rice
(3) Flavr Savr tomatoes
(4) Starlink maize.

2008

77. Main objective of production/use of herbicide resistant GM crops is to
(1) encourage eco-friendly herbicides
(2) reduce herbicide accumulation in food articles for health safety
(3) eliminate weeds from the field without the use of manual labour
(4) eliminate weeds from the field without the use of herbicides.

2008

78. Human insulin is being commercially produced from a transgenic species of
(1) Rhizobium
(2) Saccharomyces
(3) Escherichia
(4) Mycobacterium.

2006

79. Golden rice is a promising transgenic crop. When released for cultivation, it will help in
(1) producing a petrol-like fuel from rice
(2) alleviation of vitamin A deficiency
(3) pest resistance
(4) herbicide tolerance.

2006

80. In order to obtain virus-free plants through tissue culture the best method is
(1) meristem culture
(2) protoplast culture
(3) embryo rescue
(4) anther culture.

2005

81. Bacillus thuringiensis (Bt) strains have been used for designing novel
(1) biofertilizers
(2) bio-metallurgical techniques
(3) bio-mineralization processes
(4) bioinsecticidal plants.

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CHAPTER 29

Biotechnology and Its Applications

NODIA

2026 (RE-NEET)

1. The inactive form of Bt toxin is converted to the active form in the insect gut:
(1) by proteases
(2) by nucleases
(3) due to alkaline pH
(4) due to acidic pH

2026 (CANCELLED)

2. The human protein named alpha-1-antitrypsin, obtained from transgenic animals, is used for treatment of:
(1) Emphysema
(2) Alzheimer's disease
(3) Rheumatoid arthritis
(4) Cystic fibrosis

2026 (CANCELLED)

3. The toxin proteins isolated from Bacillus thuringiensis, coded by which of the following genes would control cotton bollworms and corn borer, respectively?
(1) crylAc and crylAb
(2) crylAc and crylIAb
(3) crylIAb and crylAc
(4) crylAb and crylIAb

2025

4. Given below are two statements:
Statement I: Transfer RNAs and ribosomal RNA do not interact with mRNA.
Statement II: RNA interference (RNAi) takes place in all eukaryotic organisms as a method of cellular defence.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

2025

5. Silencing of specific mRNA is possible via RNAi because of
(1) complementary tRNA
(2) non-complementary ssRNA
(3) complementary dsRNA
(4) inhibitory ssRNA.

2025

6. Which of the following genetically engineered organisms was used by Eli Lilly to prepare human insulin?
(1) Virus
(2) Phage
(3) Bacterium
(4) Yeast

2025

7. Why can't insulin be given orally to diabetic patients?
(1) Because of structural variation.
(2) Its bioavailability will be increased.
(3) Human body will elicit strong immune response.
(4) It will be digested in Gastro-Intestinal (GI) tract.

RE-EXAM 2024

8. The Bt toxin in genetically engineered, Bt cotton kills the pest by
(1) creating pores in the midgut
(2) damaging the respiratory system
(3) degenerating the nervous system
(4) altering the pH of body fluids.

RE-EXAM 2024

9. Following are the steps involved in action of toxin in Bt Cotton.
(A) The inactive toxin converted into active form due to alkaline pH of gut of insect.
(B) Bacillus thuringiensis produce crystals with toxic insecticidal proteins.
(C) The alkaline pH solubilises the crystals.
(D) The activated toxin binds to the surface of midgut cells, creates pores and causes death of the insect.
(E) The toxin proteins exists as inactive protoxins in bacteria.

ANSWERS

1. (3) due to alkaline pH
The Bt toxin exists as an inactive protoxin (crystal form). When an insect ingests it, the alkaline pH of the insect's gut solubilises and activates the crystals into the active toxin, which binds to the gut wall, killing the insect.

2. (1) Emphysema
Alpha-1-antitrypsin is a protein that protects lung tissue by inhibiting the enzyme elastase. Its deficiency leads to emphysema, a lung disorder. The protein produced from transgenic animals is therefore used to treat emphysema, helping prevent the breakdown of elastic tissue in the lungs.

3. (1) crylAc and crylAb
In Bacillus thuringiensis, the cry genes code for insecticidal toxin proteins. The genes cryIAc and cryIIAb control cotton bollworms, while cryIAb controls corn borer. As per the order asked (cotton bollworm then corn borer), the appropriate pairing is cryIAc and cryIAb, making option (1) correct.

4. (2) Statement I is incorrect but statement II is correct.
Translation involves a complex interaction between messenger RNA, transfer RNA, and ribosomal RNA to synthesize proteins. Therefore, claiming these components do not interact is biologically incorrect. However, RNA interference is a well-documented mechanism of cellular defense utilized by all eukaryotic organisms. This process effectively silences specific genes by preventing the translation of target messenger RNA molecules.

5. (3) complementary dsRNA
RNA interference is a biological process where specific messenger RNA molecules are silenced to prevent protein synthesis. This mechanism is initiated by the introduction or presence of complementary double-stranded RNA within the cell. These double-stranded molecules are processed into smaller fragments that guide enzymes to degrade target messenger RNA, thereby effectively regulating gene expression at the post-transcriptional level.

6. (3) Bacterium
The American company Eli Lilly achieved a significant milestone in biotechnology by producing human insulin using recombinant DNA technology. They prepared two DNA sequences corresponding to the A and B chains of human insulin and introduced them into the bacterium Escherichia coli. The produced chains were extracted and linked by disulfide bonds to form functional human insulin.

7. (4) It will be digested in Gastro-Intestinal (GI) tract.
Insulin is a polypeptide hormone consisting of amino acid chains linked by disulfide bonds. When administered orally, the acidic environment of the stomach and various proteolytic enzymes in the gastrointestinal tract break down the protein structure. This digestion renders the hormone inactive before it can reach the bloodstream, making oral delivery ineffective for maintaining blood glucose levels.

8. (1) creating pores in the midgut
The toxin produced by Bacillus thuringiensis is ingested by the insect as an inactive protoxin. In the alkaline environment of the insect's midgut, the protoxin is converted into an active form. This active toxin binds to the epithelial cells of the midgut, creating pores that cause cell swelling and lysis, eventually leading to death.

9. (4) B → E → C → A → D
Bacillus thuringiensis produces protein crystals containing insecticidal proteins. These exist as inactive protoxins within the bacteria. Upon ingestion by an insect, the alkaline pH of the gut solubilizes the crystals and activates the toxin. The activated toxin then binds to the midgut surface, creates pores, and causes cell lysis, which ultimately leads to the insect's death.

10. (1) Statement I is true but statement II is false.
RNA interference serves as a natural cellular defense mechanism found in all eukaryotic organisms. It typically involves the silencing of a specific messenger RNA through the action of double-stranded RNA molecules. While single-stranded RNA can bind to messenger RNA,

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while maintaining the desirable agricultural characteristics of the rice, which is a widely consumed staple food.

67. (4) Insulin
Insulin was the first therapeutic protein to be commercially produced using biotechnological procedures. Before the advent of recombinant DNA technology, insulin was extracted from the pancreases of slaughtered cattle and pigs. Today, human insulin is synthesized by genetically engineered bacteria, providing a consistent, high-quality, and non-allergenic supply for millions of people worldwide who suffer from diabetes mellitus and require regular hormone replacement.

68. (1) transgenic mice for testing safety of polio vaccine before use in humans
Genetic engineering has been utilized to create transgenic mice specifically for testing the safety of vaccines, such as the polio vaccine, before they are administered to humans. These animal models are designed to be susceptible to the disease, allowing researchers to ensure the vaccine is effective and does not cause adverse effects. This application is a critical step in ensuring public health safety.

69. (4) The inactive protoxin gets converted into active form in the insect gut.
The Bt toxin is produced by the bacterium Bacillus thuringiensis as an inactive protein crystal called a protoxin. This protoxin is harmless to the bacterium itself. However, once ingested by a susceptible insect, the alkaline pH of the insect's gut environment triggers the conversion of the protoxin into its active, toxic form. This active toxin then damages the insect's gut, leading to death.

70. (1) generated by introducing foreign DNA into a cell and regenerating a plant from that cell
Transgenic plants are developed by introducing a specific fragment of foreign DNA into the genome of a plant cell. This genetic modification is usually performed using vectors or physical methods. Once the foreign DNA is successfully integrated, the individual cell is stimulated to grow and regenerate into a whole plant through tissue culture. Every cell in the resulting plant will contain the new gene.

71. (1) insecticide
Bacillus thuringiensis is a soil-dwelling bacterium that is widely recognized in contemporary biology for its insecticidal properties. It produces specialized protein crystals that are toxic to various insect larvae. Because of this, the bacterium and its genes are used extensively to develop bioinsecticides and genetically modified crops that can protect themselves from pest damage, reducing the need for synthetic chemical pesticides in agriculture.

72. (1) When a piece of RNA that is complementary in sequence is used to stop expression of a specific gene
Antisense technology involves the use of an RNA sequence that is complementary to a specific messenger RNA. When this antisense RNA binds to the sense messenger RNA, it forms a double-stranded structure that cannot be translated into a protein. This effectively stops the expression of the target gene. This technology is used in biotechnology to regulate gene activity and study gene function.

NODIA

73. (4) tissue culture.
Somaclones are individual plants that are produced from a single parent through the process of tissue culture. Because they are derived through vegetative propagation rather than sexual reproduction, they are generally genetically identical to the parent plant. This technique allows for the rapid cloning of desirable plant varieties, ensuring that all offspring maintain the same superior traits and characteristics as the original plant.

74. (2) introducing bone marrow cells producing ADA into cells at early embryonic stages
Adenosine deaminase deficiency is a genetic disorder that can be permanently cured if functional genes are introduced into bone marrow cells during the early embryonic stages of development. At this stage, the cells are highly undifferentiated and can give rise to a lifelong supply of healthy immune cells. While other treatments like enzyme replacement exist, they are not permanent and require frequent administration.

75. (2) bollworms
Cry I endotoxins are a specific group of insecticidal proteins produced by the bacterium Bacillus thuringiensis. These proteins are particularly

20. (2) Gene silencing
Transposons are mobile genetic sequences that can change their position within a genome. In biotechnology, these elements are identified as a natural source of complementary RNA used for gene silencing through RNA interference. They can also serve as tools for gene mapping and mutagenesis. Their ability to replicate via an RNA intermediate makes them valuable for generating sequences that trigger the degradation of specific messenger RNA.

21. (4) genetically engineered lymphocytes are not immortal cells.
In the treatment of adenosine deaminase deficiency through gene therapy, functional copies of the gene are introduced into the patient's lymphocytes. These genetically engineered cells are then returned to the patient. However, because lymphocytes have a limited lifespan and are not immortal, they eventually die out. This necessitates periodic infusions of new, engineered cells to maintain the enzyme levels.

22. (1) (A), (B) and (D) only
Genetically engineered insulin is produced by synthesizing the A and B chains separately in bacteria and then joining them via disulfide bonds. Pro-hormone insulin contains a C-peptide that must be removed for maturation. While traditional insulin was derived from animals, recombinant versions avoid allergic reactions associated with foreign proteins. Therefore, statements regarding C-peptide removal and chain production in bacteria are correct.

23. (3) (ii) (i) (iv) (iii)
Plant biotechnology involves various techniques for crop improvement. Protoplast fusion is used to create somatic hybrids like the pomato. Plant tissue culture relies on the totipotency of cells to regenerate organisms. Meristem culture is specifically employed to produce virus-free plants because meristems are usually devoid of viruses. Micropropagation allows for the rapid production of numerous genetically identical plants, known as somaclones.

24. (3) gene therapy
Gene therapy is a medical technique designed to treat or prevent diseases by modifying the genetic material within an individual's cells. This process often involves targeting specific tissues to introduce, remove, or amplify genes to restore normal function. By addressing the underlying genetic cause of a condition, gene therapy aims to provide a long-term or even permanent cure for various disorders.

25. (4) mutated gene does not appear on a photographic film as the probe has no complementarity with it.
In molecular diagnostics, a radioactive probe is designed to be complementary to a specific DNA sequence. During hybridization, the probe binds only to its exact match. If a gene is mutated, the probe cannot bind due to lack of complementarity. Consequently, the mutated gene will not appear on a photographic film during autoradiography, allowing researchers to identify the genetic alteration.

26. (4) ELISA Technique
Effective disease management relies on early diagnosis and an understanding of pathophysiology. The enzyme-linked immunosorbent assay is a highly sensitive molecular diagnostic technique used for this purpose. It utilizes the specificity of antigen-antibody interactions to detect the presence of pathogens or specific proteins at very low levels, enabling early intervention before clinical symptoms of the disease become severe or evident.

27. (4) (A), (C) and (D) only
Insulin maturation involves the removal of the C-peptide from the pro-insulin molecule. Mature insulin consists of A and B polypeptide chains held together by disulfide bridges. While natural pro-insulin includes the C-peptide, insulin produced via recombinant DNA technology is often synthesized as separate chains to avoid the need for processing. Thus, C-peptide is absent in the final active hormone.

NODIA

28. (2) dysfunction of immune system
Adenosine deaminase is an essential enzyme for the proper functioning of the human immune system. Its deficiency leads to the accumulation of toxic metabolites that destroy T-lymphocytes, resulting in severe combined immunodeficiency. Patients with this condition have a highly compromised immune response, making them extremely susceptible to various infections. This genetic disorder was the first to be treated using gene therapy.

48. (3) Both apical and axillary meristems
Viruses often struggle to keep pace with the rapid cell division occurring in the actively growing regions of a plant. Therefore, the apical and axillary meristems are typically free from viral infection, even in a diseased plant. By using these tissues as explants in tissue culture, scientists can regenerate healthy, virus-free plants, which is a vital technique for agricultural crop improvement.

49. (1) insulin
Insulin was the first human hormone to be synthesized using recombinant DNA technology. In 1983, the American company Eli Lilly produced functional human insulin by creating separate DNA sequences for the A and B chains. These were expressed in the bacterium Escherichia coli and subsequently joined. This breakthrough provided a safer and more reliable source of insulin for patients with diabetes mellitus.

50. (4) Cotton
In India, the cultivation of genetically modified crops is strictly regulated. Currently, Bt cotton is the only genetically modified crop that has been approved for commercial cultivation by farmers. This crop contains genes from Bacillus thuringiensis that provide built-in resistance to major pests like the cotton bollworm. Other Bt crops, such as brinjal, have faced regulatory delays and have not been cleared.

51. (2) silencing of specific mRNA due to complementary RNA
RNA interference is a post-transcriptional gene silencing mechanism. It involves the introduction of double-stranded RNA that is complementary to a target messenger RNA sequence. Once inside the cell, the double-stranded RNA is processed to guide a complex that binds and degrades the specific messenger RNA. This prevents the translation process, thereby silencing the expression of the targeted gene within the organism.

52. (1) genetically uniform population identical to the original parent
Tissue culture allows for the rapid production of thousands of plantlets from a small amount of parental tissue, a process known as micropropagation. The primary economic advantage of this technique is the ability to generate a large population of plants that are genetically uniform and identical to the original parent. These identical individuals, or clones, ensure consistency in crop quality and yield.

53. (2) Somatic embryos can develop from microspores.
Somatic embryogenesis is the process where embryos develop from somatic cells rather than gametes. These embryos follow a developmental pattern similar to zygotic embryos. This process can be induced using growth regulators like auxins, such as 2,4-D. While somatic embryos can arise from various vegetative tissues, they do not typically develop from microspores, which are instead used to produce haploid plants.

54. (1) Adenovirus
Gene therapy aims to treat genetic disorders by replacing a defective gene with a functional one. This process requires a delivery vehicle, or vector, to transport the gene into the patient's cells. Adenoviruses are commonly used as vectors because they can efficiently infect both dividing and non-dividing cells. These viruses are modified to be harmless while still retaining their ability to deliver genetic material.

55. (3) Golden rice
Vitamin A deficiency is a significant cause of preventable blindness in developing countries. Golden rice was genetically engineered to produce beta-carotene, which the human body can convert into vitamin A. By incorporating this trait into a staple food like rice, scientists aim to provide a sustainable dietary source of the nutrient, potentially reducing the incidence of night blindness and associated health problems.

56. (1) both sense and anti-sense RNA
Tobacco plants were made resistant to the nematode Meloidogyne incognita using RNA interference. This involved introducing DNA that produces both sense and anti-sense RNA within the host cells. These two RNA strands are complementary and form double-stranded RNA. When the nematode ingests these molecules, they trigger a silencing mechanism that degrades essential nematode messenger RNA, preventing the parasite from surviving in the plant.

57. (3) Meristem
The meristematic regions of a plant, such as the shoot apex, are generally free of viruses even when the rest of the plant is infected. This is

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root knots or galls, which significantly reduces the plant's ability to absorb water and nutrients. Consequently, the overall growth and yield of the tobacco crop are severely impacted, making this nematode a major agricultural pest for farmers worldwide.

39. (1) Gene therapy
In 1990, the first clinical gene therapy was performed on a four-year-old girl suffering from adenosine deaminase deficiency. This condition is caused by a genetic defect that impairs the immune system. The treatment involved extracting the patient's lymphocytes, introducing a functional copy of the gene, and then returning the modified cells to her body to restore enzyme production and immune function.

40. (2) disulphide bridges
Human insulin consists of two distinct polypeptide chains, referred to as chain A and chain B. These two chains are held together by specific chemical linkages known as disulfide bridges. These bridges form between cysteine residues in the two chains, providing the necessary structural stability for the hormone to function correctly in regulating glucose metabolism throughout the human body.

41. (2) vitamin A
Golden rice is a genetically engineered crop designed to provide a source of vitamin A in regions where rice is a staple food. Scientists incorporated genes responsible for the biosynthesis of beta-carotene, which the human body can convert into vitamin A. This modification aims to reduce the prevalence of vitamin A deficiency, which can lead to blindness and other health issues.

42. (3) alkaline pH of the insect gut
The insecticidal protein in Bt cotton exists as an inactive protoxin within the plant tissues. Upon ingestion by a susceptible insect, the protein enters the gut environment. The alkaline pH found in the insect's midgut facilitates the solubilization and subsequent cleavage of the protoxin into its active toxic form. This activation is critical for the toxin to bind to gut cells.

43. (2) herbicides
Glyphosate is a broad-spectrum herbicide used to kill weeds that compete with crops for nutrients and sunlight. Scientists have developed genetically engineered crops that are resistant or tolerant to glyphosate. These "Roundup Ready" crops allow farmers to spray their entire fields with the herbicide, effectively killing the weeds without harming the engineered crop plants, thereby simplifying weed management and improving yields.

44. (2) without cell wall
In plant biology, a protoplast refers to the living part of a plant cell where the surrounding cell wall has been removed. This is typically achieved through enzymatic digestion using cellulase and pectinase. Once the wall is gone, the cell is bounded only by the plasma membrane. Protoplasts are essential for various biotechnological procedures, including genetic transformation and somatic hybridization between different species.

NODIA

45. (4) somatic embryogenesis.
Micropropagation is a tissue culture technique used to rapidly multiply plant species. One major pathway for this process is somatic embryogenesis, where embryos are developed from vegetative or somatic cells rather than from the fusion of gametes. These somatic embryos can then germinate and grow into independent plants that are genetically identical to the parent, allowing for large-scale production of uniform crops.

46. (4) Polyethylene glycol and sodium nitrate
Somatic hybridization involves the fusion of isolated protoplasts from different plant varieties. To successfully induce this fusion, specific chemical agents or physical methods are required. Polyethylene glycol is a widely used chemical fusogen that alters the plasma membrane to facilitate contact and merging. Additionally, sodium nitrate can be used to enhance the fusion process, allowing for the creation of hybrid cells.

47. (1) Genetic Engineering Approval Committee
The Genetic Engineering Approval Committee is the primary regulatory body in India under the Ministry of Environment, Forest and Climate Change. Its mandate includes regulating research, testing, and the commercial release of genetically modified organisms and products. The committee ensures that all biotechnological advancements meet safety standards for both the public and the environment before they are introduced into the market.

29. (1) insect pests
Genetically modified Bt cotton was developed by incorporating specific toxin genes from the soil bacterium Bacillus thuringiensis. This modification enables the plant to produce its own insecticidal proteins. These proteins are toxic to certain insect pests, particularly bollworms, which belong to the order Lepidoptera. By providing built-in resistance, Bt cotton reduces the need for external chemical pesticides during crop cultivation.

30. (1) (iv) (i) (ii) (iii)
Bt cotton utilizes genes from Bacillus thuringiensis to provide insect resistance. Adenosine deaminase deficiency is a primary target for clinical gene therapy. RNA interference is a mechanism used for cellular defense in eukaryotes by silencing specific genes. The polymerase chain reaction is a versatile molecular tool used for the early detection of various viral infections, including the human immunodeficiency virus.

31. (3) The functional insulin has A and B chains linked together by hydrogen bonds.
Human insulin is synthesized as a pro-insulin molecule containing A, B, and C peptides. During maturation, the C-peptide is removed, and the A and B chains are linked by disulfide bonds. Genetically engineered insulin is produced using bacteria like Escherichia coli. The claim that the chains are linked by hydrogen bonds is incorrect, as disulfide bridges are essential for its stability.

32. (4) Alkaline pH of gut
Bacillus thuringiensis produces protein crystals that contain inactive protoxins. When an insect, such as a bollworm, ingests these crystals, they are solubilized in the gut. The alkaline pH of the insect's midgut provides the specific environment required to convert these inactive protoxins into an active toxic form. This activated toxin then binds to the gut wall, eventually causing the insect's death.

33. (2) It is vitamin A enriched, with a gene from daffodil.
Golden rice is a genetically modified variety of rice developed to address nutritional deficiencies. It is enriched with beta-carotene, a precursor of vitamin A, which gives the grains a distinctive yellow or golden color. This enhancement was achieved by introducing specific genes from the daffodil plant and certain bacteria into the rice genome, making it a valuable tool for public health.

34. (1) ds-RNA
RNA interference is a regulatory mechanism where gene expression is silenced at the post-transcriptional level. This process is mediated by double-stranded RNA molecules that are processed into small interfering RNAs. These small RNAs guide a protein complex to identify and degrade specific messenger RNA sequences. By destroying the messenger RNA, the cell prevents the synthesis of the corresponding protein, effectively silencing the gene.

35. (4) Basmati.
Basmati rice is a unique variety known for its distinct aroma and long grains, traditionally grown in India for centuries. In 1997, a foreign company obtained a patent for a "new" variety of Basmati rice, claiming it was an invention. This led to significant controversy regarding biopiracy and the protection of traditional knowledge and agricultural resources belonging to indigenous populations.

36. (4) Genetic Engineering Appraisal Committee (GEAC).
The Indian government established the Genetic Engineering Approval Committee to oversee biotechnology activities. This organization is responsible for evaluating the validity and safety of genetically modified research and ensuring that the introduction of modified organisms for public use does not pose risks to the environment or human health. It plays a critical role in regulating the ethical and safe use of technology.

37. (2) biopiracy
Biopiracy refers to the unethical practice where multinational companies or other organizations use biological resources and traditional knowledge from a country without obtaining proper authorization. This often happens without providing fair compensation or recognition to the indigenous people or the concerned nation. It highlights the need for international regulations and benefit-sharing agreements to protect global biodiversity and local cultural heritage.

38. (2) Root
The nematode Meloidogyne incognita is a common parasite that infects the roots of tobacco plants. This infection leads to the formation of

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due to the rapid rate of cell division and the lack of vascular connections in the pro-meristem. Therefore, meristem culture is the most effective method for obtaining virus-free plants through micropropagation and tissue culture techniques.

58. (4) adenosine deaminase deficiency.
The first clinical application of gene therapy occurred in 1990 for a young patient with adenosine deaminase deficiency. This rare genetic disorder leads to severe combined immunodeficiency because the absence of the enzyme is toxic to immune cells. The treatment involved the insertion of a functional gene into the patient's white blood cells to restore the necessary immune system function and enzyme levels.

59. (1) nematodes
RNA interference technology has been successfully applied to develop plants that are resistant to parasitic nematodes. For example, tobacco plants were modified to silence specific genes in the nematode Meloidogyne incognita. When the nematode feeds on the transgenic plant, the silencing molecules enter its system and block essential protein production, thereby protecting the plant from the damaging effects of the nematode infection.

60. (1) binds with epithelial cells of midgut of the insect pest ultimately killing it
Bacillus thuringiensis produces protein crystals during a specific phase of its growth. These crystals contain insecticidal proteins that act as a stomach poison. When an insect eats these proteins, they are activated in the gut and bind to the epithelial cells of the midgut. This binding creates pores in the cell membrane, leading to swelling, lysis, and eventually the death of the pest.

61. (2) nematodes
Silencing of messenger RNA through RNA interference is a powerful tool in biotechnology. This technique has been specifically used to create transgenic tobacco plants that are resistant to the root-knot nematode. By expressing double-stranded RNA that targets essential nematode genes, the plants can effectively stop the parasite from reproducing and causing disease, demonstrating a sophisticated approach to pest management in modern agriculture.

62. (2) mice
Transgenic animals are created for various purposes, including medical research and the production of therapeutic proteins. Among all existing transgenic animals, mice are by far the most numerous, accounting for over ninety-five percent of the total population. Their small size, short generation time, and well-understood genetics make them ideal models for studying human diseases and testing the safety of new medical treatments.

63. (4) A and B
Rosie was actually a transgenic cow, not a buffalo, that produced human protein-enriched milk. Additionally, restriction enzymes are molecular tools used to cut DNA at specific sequences, rather than being used for the general isolation of DNA from other cellular macromolecules. Downstream processing and the use of disarmed pathogen vectors are standard and correctly described steps in recombinant DNA technology and gene transfer.

64. (1) insect-resistance
Genetically modified brinjal in India was developed to provide resistance against the fruit and shoot borer, which is a major insect pest. This was achieved by introducing the cryIAc gene from the soil bacterium Bacillus thuringiensis. The toxin produced by this gene specifically targets the larvae of the pest, reducing the need for chemical insecticides and potentially increasing the yield for farmers.

NODIA

65. (4) high yield and resistance to bollworms.
Bt cotton is characterized by its high yield and its ability to resist infestation by bollworms. It produces insecticidal protein crystals derived from Bacillus thuringiensis. These proteins are specifically toxic to lepidopteran insects like bollworms. By incorporating this trait, the cotton plant gains a built-in defense mechanism, leading to reduced crop damage and a decreased reliance on external chemical pesticides during the growing season.

66. (2) gives high yield and is rich in vitamin A
Golden rice is an improved variety that has been genetically engineered to provide higher yields and increased nutritional value. A notable example is its enrichment with beta-carotene, which the body converts into vitamin A. This modification aims to address dietary deficiencies

the mechanism fundamentally relies on the processing of double-stranded precursors into small interfering RNAs to initiate the silencing process.

11. (3) Statement I is true but Statement II is false.
Toxins from Bacillus thuringiensis are specific to certain insect groups and are encoded by cry genes like cryIAc. These proteins are produced as inactive protoxins that require an alkaline environment for activation. The assertion that they are activated by acidic pH is incorrect, as the alkaline conditions of the insect's midgut are necessary to solubilize the toxic crystals.

12. (1) totipotency
In plant biology, the inherent capacity of a single cell to divide and differentiate into a complete, functioning organism is known as totipotency. This remarkable property allows scientists to regenerate entire plants from small explants or even isolated cells under controlled laboratory conditions. It forms the fundamental basis for various tissue culture techniques used in modern plant biotechnology.

13. (3) Protoplasts
Somatic hybridization is a technique where the cell walls of two different plant varieties are removed using specific enzymes. This process results in isolated protoplasts, which are then induced to fuse together in a culture medium. The resulting hybrid protoplast contains genetic material from both parents and can be regenerated into a new plant with desired traits from both.

14. (4) A-II, B-IV, C-I, D-III
Recombinant DNA technology allows the production of human insulin in bacteria like Escherichia coli. Genetically modified cotton incorporates toxins from Bacillus thuringiensis for pest resistance. Adenosine deaminase deficiency is addressed through gene therapy techniques. Enzyme-linked immunosorbent assay is a diagnostic tool based on the specific interaction between antigens and antibodies to detect various pathogens or medical conditions.

15. (3) A-III, B-IV, C-I, D-II
Alpha-1 antitrypsin is a protein used in the medical treatment of emphysema. Specific cry genes like CryIAb and CryIAc provide resistance against corn borers and cotton bollworms, respectively. Enzyme replacement therapy is a common clinical approach for managing adenosine deaminase deficiency. These biotechnological applications demonstrate the diverse use of genetic engineering in medicine and agriculture to solve human problems.

16. (1) Statement I is true but statement II is false.
The Genetic Engineering Approval Committee is the Indian government body responsible for regulating research and assessing the safety of genetically modified organisms. Biopiracy refers to the exploitation of biological resources and traditional knowledge by organizations without proper authorization or compensation to the source country. While the first statement correctly describes a regulatory fact, the second statement is false as it misrepresents the unauthorized nature of biopiracy.

17. (3) (A)-(IV), (B)-(III), (C)-(II), (D)-(I)
Gene therapy is used to correct genetic defects by introducing functional genes. RNA interference acts as a cellular defense mechanism by silencing specific messenger RNA molecules. The enzyme-linked immunosorbent assay is a standard diagnostic test for detecting infections like AIDS. Gel electrophoresis is a fundamental laboratory technique utilized to separate DNA fragments or proteins based on their size and charge.

18. (1) Mature insulin molecule consists of three polypeptide chains-A, B and C.
A mature and functional insulin molecule consists of two polypeptide chains, designated as chain A and chain B, which are linked by disulfide bridges. During its synthesis as a prohormone, an additional segment called the C-peptide is present. This C-peptide is removed during the maturation process, meaning it is not found in the final, active insulin hormone molecule.

19. (4) Serum and Urine analysis
Early diagnosis of diseases is crucial for effective treatment and is facilitated by modern molecular techniques. Methods like the polymerase chain reaction, recombinant DNA technology, and enzyme-linked immunosorbent assays can detect pathogens or genetic mutations even at very low concentrations. In contrast, traditional methods like serum and urine analysis are generally unable to provide such early or specific detection.

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effective against certain types of insect pests, most notably bollworms, which are the larvae of moths that cause extensive damage to cotton crops. By introducing the genes for these toxins into plants, scientists can create crops that are naturally protected from these pests.

76. (2) Golden rice
Golden rice is a transgenic food crop specifically engineered to combat vitamin A deficiency in developing nations. This deficiency is a leading cause of night blindness and other serious health issues. By introducing genes that enable the biosynthesis of beta-carotene in the rice grains, researchers have created a sustainable way to deliver this essential nutrient through a widely consumed staple food source.

77. (3) eliminate weeds from the field without the use of manual labour
The primary goal of developing genetically modified crops that are resistant to herbicides is to simplify weed control in agricultural fields. Farmers can apply broad-spectrum herbicides to their entire crop area without damaging the resistant plants. This effectively eliminates competing weeds without the need for intensive manual labor or mechanical cultivation, leading to more efficient farming practices and potentially higher crop yields.

78. (3) Escherichia
Human insulin is now commercially produced using a transgenic species of the bacterium Escherichia coli. This was achieved by inserting the human genes for the A and B chains of insulin into the bacteria. The bacteria then act as biological factories, producing large quantities of the protein chains, which are later extracted and chemically linked to form the active hormone used by diabetic patients.

79. (2) alleviation of vitamin A deficiency
Golden rice is a significant advancement in agricultural biotechnology, designed to alleviate vitamin A deficiency in populations that rely heavily on rice. This transgenic variety is engineered to contain higher levels of beta-carotene, the precursor for vitamin A. Since vitamin A is essential for healthy vision and immune function, cultivating golden rice could significantly reduce the incidence of blindness in children worldwide.

NODIA

80. (1) meristem culture
Meristem culture is the most effective tissue culture technique for producing plants that are free from viral infections. Because the cells in the shoot apical meristem divide very rapidly and lack a developed vascular system, viruses are often unable to infect these tissues. By excising the meristem and growing it in a sterile medium, researchers can regenerate a completely healthy and virus-free plant.

81. (4) bioinsecticidal plants.
Strains of the bacterium Bacillus thuringiensis have been utilized by scientists to design and develop novel bioinsecticidal plants. These genetically modified crops, such as Bt cotton and Bt corn, produce their own insecticidal proteins. This internal defense mechanism provides targeted protection against specific insect pests, reducing the environmental impact and cost associated with the heavy application of traditional chemical sprays in modern farming.

82. (4) high vitamin-A content.
Golden rice is considered a revolutionary transgenic crop because it has been improved with a high vitamin A content. Scientists achieved this by engineering the rice to produce beta-carotene in its endosperm. This trait is intended to help populations suffering from malnutrition, particularly in areas where rice is the primary calorie source but dietary variety and essential micronutrients like vitamin A are lacking.

83. (4) the genetic code is universal.
The production of human proteins in bacteria is possible because the genetic code is universal across almost all living organisms. This means that a specific sequence of DNA bases will code for the same amino acids whether it is inside a human cell or a bacterial cell. Therefore, bacteria can accurately translate human genetic information to synthesize functional human proteins like insulin or growth hormones.

84. (3) micropropagation
Micropropagation is a tissue culture technique used to produce a vast number of small plants, or plantlets, in a relatively short period. This method utilizes the totipotency of plant cells to regenerate whole organisms from tiny pieces of tissue. It is highly efficient for commercial plant production, ensuring that all the resulting

plantlets are genetically identical and free from many common soil-borne diseases.

85. (1) alkaline phosphatase
The enzyme-linked immunosorbent assay is a diagnostic tool used to detect the presence of specific antigens or antibodies in a sample. A key reagent in this process is an enzyme, such as alkaline phosphatase or peroxidase, which is chemically linked to an antibody. When the enzyme reacts with a substrate, it produces a color change, indicating a positive result for the target pathogen.

86. (4) reporter.
In transgenic research, a reporter gene is used to determine whether a transgene is being successfully expressed in the target tissue. These genes produce a detectable signal, such as a fluorescent protein or a specific enzyme activity, when they are active. By observing this signal, scientists can confirm that the genetic modification is working as intended and monitor where the gene is active.

87. (2) all plant cells
Cellular totipotency is the unique ability of an individual plant cell to divide and differentiate into all the different types of cells required to form a complete, multi-cellular organism. This remarkable property is demonstrated by almost all living plant cells. It is the fundamental principle that allows for the regeneration of entire plants from small tissue samples in laboratory culture environments.

88. (3) vaccines
Animal cell culture technology is extensively used in modern medicine and biotechnology. Currently, its most significant application is in the large-scale production of various vaccines. By growing viruses or specific proteins in cultured animal cells, manufacturers can create the necessary components for immunizations against numerous diseases. This technology ensures a steady and controlled supply of vital medical products to protect public health.

89. (1) cellular totipotency
In tissue culture, the formation of embryoids from haploid pollen grains is a clear demonstration of cellular totipotency. This means that even specialized reproductive cells like microspores have the genetic potential to reorganize and develop into an entire embryo under appropriate hormonal conditions. This technique is particularly useful for plant breeders because it allows for the rapid production of homozygous diploid plant lines.

90. (1) cytokinin
Coconut milk is a common additive in plant tissue culture media because it is a rich natural source of cytokinins, particularly zeatin. These plant hormones are essential for promoting cell division and stimulating the growth of shoots from undifferentiated callus tissue. The presence of these growth factors helps to accelerate the development of plantlets, making it an invaluable component for successful micropropagation.

91. (1) tobacco
Tobacco was the first crop plant to be successfully genetically modified using recombinant DNA technology. In the early 1980s, researchers demonstrated that foreign genes could be inserted into the tobacco genome and successfully expressed. This pioneering work paved the way for the development of many other transgenic crops with improved traits, such as pest resistance, herbicide tolerance, and enhanced nutritional content in modern agriculture.

92. (3) human insulin
The term 'humulin' specifically refers to human insulin that is produced using recombinant DNA technology. Before this technology was available, insulin for diabetic patients was obtained from animals, which often caused allergic reactions. Humulin is chemically identical to the insulin produced by the human pancreas, making it a safer and more effective treatment for managing blood sugar levels in patients with diabetes.

93. (4) hybrid cells resulting from myeloma cells.
Hybridoma cells are created by the artificial fusion of a specific antibody-producing B-lymphocyte with a cancerous myeloma cell. The resulting hybrid cell possesses the unique properties of both parents: it can produce a specific monoclonal antibody and has the ability to divide indefinitely in culture. These cells are essential for producing large quantities of pure antibodies used in diagnostic tests and medical therapies.

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94. (3) foreign DNA in all its cells
Transgenic animals are defined as organisms that have had their genome intentionally modified by the introduction of a foreign DNA sequence. For an animal to be truly transgenic, this foreign genetic material must be present in all of its cells, including the germ cells. This ensures that the newly acquired trait can be passed down to future generations, allowing for permanent genetic change.

95. (3) F.C. Steward
The concept of cellular totipotency was experimentally demonstrated by the scientist F.C. Steward in the late 1950s. Using cells from a carrot root, he showed that individual, specialized plant cells could be stimulated to grow into a complete, normal carrot plant when provided with the correct nutrients and hormones. This groundbreaking experiment confirmed that all plant cells contain the complete genetic blueprint.

96. (4) Young pollen grains
In the process of anther culture, androgenic haploids are produced directly from the young pollen grains or microspores. These haploid cells are stimulated to divide and develop into embryos or plantlets without fertilization. Because they contain only one set of chromosomes, these plants are extremely valuable in genetic research and plant breeding for the rapid development of completely homozygous and pure lines.

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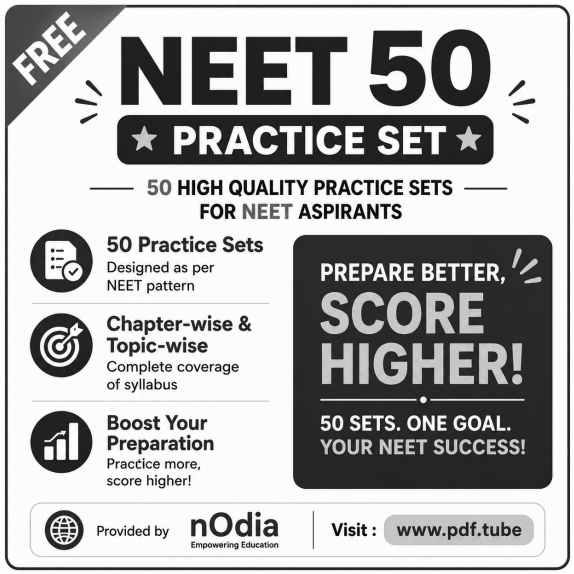

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2024

14. The equation of Verhulst-Pearl logistic growth is $dN/dt = rN[(K-N)/K]$
From this equation, K indicates
(1) intrinsic rate of natural increase
(2) biotic potential
(3) carrying capacity
(4) population density.

2024

15. Given below are two statements:
Statement I : Gause's competitive exclusion principle states that two closely related species competing for different resources cannot exist indefinitely.
Statement II : According to Gause's principle, during competition, the inferior will be eliminated. This may be true if resources are limiting.
In the light of the above statements, choose the correct answer from the options given below.
(1) Both Statement I and Statement II are true.
(2) Both Statement I and Statement II are False.
(3) Statement I is true but Statement II is false.
(4) Statement I is false but Statement II is true.

Manipur NEET 2023

16. Plants offer rewards to animals in the form of pollen and nectar and the animals facilitate the pollination process. This is an example of
(1) amensalism
(2) competition
(3) commensalism
(4) mutualism.

Manipur NEET 2023

17. If there are 250 snails in a pond, and within a year their number increases to 2500 by reproduction. What should be their birth rate per snail per year?
(1) 10
(2) 9
(3) 25
(4) 15

Manipur NEET 2023

18. For chemical defence against herbivores, Calotropis has
(1) cardiac glycosides
(2) strychnine
(3) toxic ricin
(4) distasteful quinine.

2023

19. Match List I with List II :

	List I (Interaction)		List II (Species A and B)
A.	Mutualism	I.	+(A), 0(B)
B.	Commensalism	II.	-(A), 0(B)
C.	Amensalism	III.	+(A), -(B)
D.	Parasitism	IV.	+(A), +(B)

Choose the correct answer from the options given below :
(1) A-IV, B-III, C-I, D-II
(2) A-III, B-I, C-IV, D-II
(3) A-IV, B-II, C-I, D-III
(4) A-IV, B-I, C-II, D-III

NODIA

2023

20. Given below are two statements :
Statement I : Gause's 'Competitive Exclusion Principle' states that two closely related species competing for the same resources cannot co-exist indefinitely and competitively inferior one will be eliminated eventually.
Statement II : In general, carnivores are more adversely affected by competition than herbivores.
In the light of the above statements,choose the most appropriate answer from the options given below:
(1) Statement I is correct but Statement II is false.
(2) Statement I is incorrect but Statement II is true.
(3) Both Statement I and Statement II are true.
(4) Both Statement I and Statement II are false.

2023

21. Match List I with List II.

	List-I		List-II
A.	Logistic growth	I.	Unlimited resource availability condition
B.	Exponential growth	II.	Limited resource availability condition
C.	Expanding age pyramid	III.	The percent individuals growth of pre-reproductive age is largest followed by reproductive and post reproductive age groups

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement are correct.
(4) Both statement I and statement II are incorrect.

RE-EXAM 2024

10. When will the population density increase, under special conditions?

When the number of

(1) deaths exceeds number of births and also number of emigrants equals number of immigrants
(2) births plus number of immigrants equals number of deaths plus number of emigrants
(3) births plus number of emigrants is more than the number of deaths plus number of immigrants
(4) births plus number of immigrants is more than the sum of number of deaths and number of emigrants.

RE-EXAM 2024

11. Match List-I with List-II.

	List-I		List-II
A.	Predator	I.	Ophrys
B.	Mutualism	II.	Pisaster
C.	Parasitism	III.	Female wasp and fig
D.	Sexual deceit	IV.	Plasmodium

Choose the correct answer from the options given below.

(1) A-III, B-II, C-I, D-IV
(2) A-IV, B-I, C-II, D-III
(3) A-II, B-III, C-I, D-IV
(4) A-II, B-III, C-IV, D-I

RE-EXAM 2024

12. Match List-I with List-II.

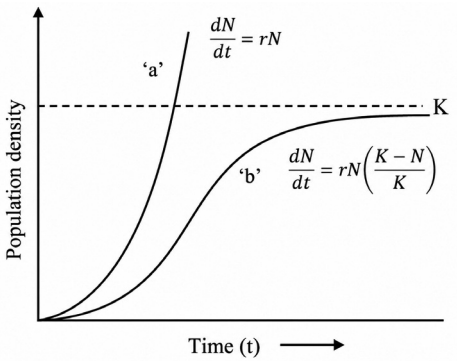
	List-I		List-II
A	Migratory flamingoes and resident fish in South American lakes	I	Interference competition
B	Abingdon tortoise became extinct after introduction of goats in their habitat	II	Competitive release
C	Chthamalus expands its distributional range in the absence of Balanus	III	Resource partitioning
D	Five closely related species of warblers feeding in different locations on same tree	IV	Interspecific competition

Choose the correct answer from the options given below.

(1) A-I, B-IV, C-III, D-II
(2) A-IV, B-I, C-II, D-III
(3) A-III, B-I, C-II, D-IV
(4) A-II, B-IV, C-III, D-I

RE-EXAM 2024

13. What do 'a' and 'b' represent in the following population growth curve?



(1) 'a' represents exponential growth when responses are not limiting the growth; and 'b' represents logistic growth when responses are limiting the growth.
(2) 'a' represents logistic growth when responses are not limiting the growth, 'b' represents exponential growth when responses are limiting the growth.
(3) 'a' represents carrying capacity and 'b' shows logistic growth when responses are limiting the growth.
(4) 'a' represents exponential growth when responses are not limiting the growth and 'b' shows carrying capacity.

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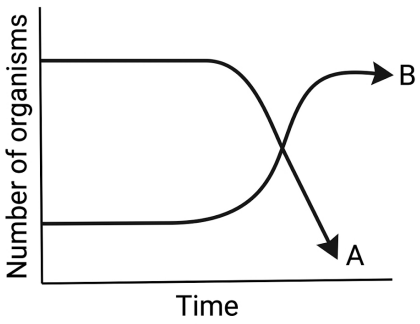

(1) population A produced more offspring than population B
(2) population A consumed the members of population B
(3) both plant populations in this habitat decreased
(4) population B competed more successfully for food than population A.

2014

54. Just as a person moving from Delhi to Shimla to escape the heat for the duration of hot summer, thousands of migratory birds from Siberia and other extremely cold northern regions move to
(1) Western Ghat
(2) Meghalaya
(3) Corbett National Park
(4) Keoladeo National Park.

Karnataka NEET 2013

55. Which one of the following is not a parasitic adaptation?
(1) Development of adhesive organs
(2) Loss of digestive organs
(3) Loss of reproductive capacity
(4) Loss of unnecessary sense organs

Karnataka NEET 2013

56. Benthic organisms are affected the most by
(1) light reaching the forest floor
(2) surface turbulence of water
(3) sediment characteristics of aquatic ecosystems
(4) water-holding capacity of soil.

2013

57. According to Darwin, the organic evolution is due to
(1) competition within closely related species
(2) reduced feeding efficiency in one species due to the presence of interfering species
(3) intraspecific competition
(4) interspecific competition.

2013

58. Besides paddy fields, cyanobacteria are also found inside vegetative part of
(1) Equisetum
(2) Psilotum
(3) Pinus
(4) Cycas.

2013

59. A sedentary sea anemone gets attached to the shell lining of hermit crab. The association is
(1) commensalism
(2) amensalism
(3) ectoparasitism
(4) symbiosis.

2013

60. A biologist studied the population of rats in a barn. He found that the average natality was 250, average mortality 240, immigration 20 and emigration 30. The net increase in population is
(1) 05
(2) zero
(3) 10
(4) 15.

Karnataka NEET 2013

61. The age pyramid with broad base indicates
(1) high percentage of old individuals
(2) low percentage of young individuals
(3) a stable population
(4) high percentage of young individuals.

2012

62. People who have migrated from the planes to an area adjoining Rohtang Pass about six months back
(1) have more RBCs and their haemoglobin has a lower binding affinity to O_2
(2) are not physically fit to play games like football
(3) suffer from altitude sickness with symptoms like nausea, fatigue, etc.
(4) have the usual RBC count but their haemoglobin has very high binding affinity to O_2.

Mains 2012

63. Cuscuta is an example of
(1) ectoparasitism
(2) brood parasitism
(3) predation
(4) endoparasitism.

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D.	Stable age pyramid	IV.	The percent individuals of pre-reproductive and reproductive age group are same

Choose the correct answer from the options given below:
(1) A-II, B-IV, C-I, D-III
(2) A-II, B-IV, C-III, D-I
(3) A-II, B-I, C-III, D-IV
(4) A-II, B-III, C-I, D-IV

2023

22. Match List I with List II.

	List I (Interacting species)		List II (Name of Interaction)
A.	A Leopard and a lion in a forest/ grassland	I.	Competition
B.	A cuckoo laying egg in a Crow's nest	II.	Brood parasitism
C.	Fungi and root of a higher plant in mycorrhizae	III.	Mutualism
D.	A cattle egret and a cattle in a field	IV.	Commensalism

Choose the correct answer from the options given below:
(1) A-III, B-IV, C-I, D-II
(2) A-II, B-III, C-I, D-IV
(3) A-I, B-II, C-III, D-IV
(4) A-I, B-II, C-IV, D-III

2022

23. Which one of the following statements cannot be connected to predation?
(1) It helps in maintaining species diversity in a community.
(2) It might lead to extinction of a species.
(3) Both the interacting species are negatively impacted.
(4) It is necessitated by nature to maintain the ecological balance.

2022

24. While explaining interspecific interaction of population, (+) sign is assigned for beneficial interaction, (-) sign is assigned for detrimental interaction and (0) for neutral interaction. Which of the following interactions can be assigned (+) for one species and (-) for another species involved in the interaction?
(1) Predation
(2) Amensalism
(3) Commensalism
(4) Competition

2022

25. If '8' Drosophila in a laboratory population of '80' died during a week, the death rate in the population is ..... individuals per Drosophila per week.
(1) 0.1
(2) 10
(3) 1.0
(4) zero

2021

26. Match List- I with List- II.

	List-I		List-II
(p)	Allen's Rule	(i)	Kangaroo rat
(q)	Physiological adaptation	(ii)	Desert lizard
(r)	Behavioural adaptation	(iii)	Marine fish at depth
(s)	Biochemical adaptation	(iv)	Polar seal

Choose the correct answer from the options given below.
(1) (p)-(iv); (q)-(iii); (r)-(ii); (s)-(i)
(2) (p)-(iv); (q)-(ii); (r)-(iii); (s)-(i)
(3) (p)-(iv); (q)-(i); (r)-(iii); (s)-(ii)
(4) (p)-(iv); (q)-(i); (r)-(ii); (s)-(iii)

2021

27. **Assertion (A) :** A person goes to high altitude and experiences 'altitude sickness' with symptoms like breathing difficulty and heart palpitations.
Reason (R) : Due to low atmospheric pressure at high altitude, the body does not get sufficient oxygen.
In the light of the above statements, choose the correct answer from the options given below.
(1) (A) is false but (R) is true.
(2) Both (A) and (R) are true and (R) is the correct explanation of (A).
(3) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(4) (A) is true but (R) is false.

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CHAPTER 30
Organisms and Populations

2026 (RE-NEET)

1. Match List-I with List-II:

List-I

A. Both species harmed;
B. One harmed, one benefited;
C. Both benefited;
D. One benefited, other unaffected.

List-II

I. Predation,
II. Mutualism,
III. Competition,
IV. Commensalism

Choose the correct answer from these options given below :

(1) A-II, B-I, C-IV, D-III
(2) A-III, B-I, C-II, D-IV
(3) A-III, B-IV, C-II, D-I
(4) A-I, B-II, C-III, D-IV

2026 (RE-NEET)

2. A population of 10 million cells. Per-capita birth rate 0.002 and per-capita death rate 0.002 (per unit time). The expected number of cells after 10 generations is ___.

(1) 10 million
(2) 100 million
(3) 1 million
(4) 5 million

2026 (RE-NEET)

3. Assertion A: The logistic growth model of populations is considered more realistic than the exponential growth model. Reason R: Resources are finite.

(1) A is correct but R is not correct
(2) A is not correct but R is correct
(3) Both A and R are correct and R is the correct explanation of A
(4) Both A and R are correct but R is not the correct explanation of A

2026 (CANCELLED)

4. Which of the following equations depicts Verhulst-Pearl logistic population growth?

(1) $dN/dt = rN\ ((K+N)/K)$
(2) $dN/dt = rN\ ((K-N)/K)$
(3) $dN/dt = rN\ ((K-N)/N)$
(4) $dN/dt = rN\ (K/(K-N))$

2026 (CANCELLED)

5. Choose the correct statements regarding population interactions between two species:

A. In both parasitism and commensalism, only one species benefits and the other species is harmed.
B. Both species benefit in mutualism.
C. Both species benefit in commensalism.
D. In parasitism, only one species benefits and the other species is harmed.
E. In amensalism, one species is harmed and the other is unaffected.

Choose the correct answer from the options given below:

(1) B and E only
(2) A and B only
(3) B, D and E only
(4) A and D only

2025

6. Who is known as the father of Ecology in India?

(1) Ram Udar (2) Birbal Sahni
(3) S.R. Kashyap (4) Ramdeo Misra

2025

7. Which one of the following equations represents the Verhulst-Pearl Logistic Growth of population?

(1) $dN/dt = rN[(N-K)/N]$
(2) $dN/dt = N[(r-K)/K]$
(3) $dN/dt = r[(K-N)/K]$
(4) $dN/dt = rN[(K-N)/K]$

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2025

Epiphytes that are growing on a mango branch is an example of which of the following?

(1) Predation
(2) Amensalism
(3) Commensalism
(4) Mutualism

2025

9. Given below are two statements:

Statement I: Fig fruit is a non-vegetarian fruit as it has enclosed fig wasps in it.

Statement II: Fig wasp and fig tree exhibit mutual relationship as fig wasp completes its life cycle in fig fruit and fig fruit gets pollinated by fig wasp.

2017

41. Presence of plants arranged into well defined vertical layers depending on their height can be seen best in
(1) tropical rainforest
(2) grassland
(3) temperate forest
(4) tropical savannah.

2017

42. Asymptote in a logistic growth curve is obtained when
(1) K = N
(2) K > N
(3) K < N
(4) the value of 'r' approaches zero.

2017

43. Mycorrhizae are the example of
(1) amensalism
(2) antibiosis
(3) mutualism
(4) fungistasis.

NEET-I 2016

44. It is much easier for a small animal to run uphill than for a large animal, because
(1) small animals have a lower O_2 requirement
(2) the efficiency of muscles in large animals is less than in the small animals
(3) it is easier to carry a small body weight
(4) smaller animals have a higher metabolic rate.

NEET-II 2016

45. Which of the following is correct for r-selected species?
(1) Large number of progeny with small size
(2) Large number of progeny with large size
(3) Small number of progeny with small size
(4) Small number of progeny with large size

NEET-II 2016

46. If '+' sign is assigned to beneficial interaction, '-' sign to detrimental and 'O' sign to neutral interaction, then the population interaction represented by '+' '-' refers to
(1) mutualism
(2) amensalism
(3) commensalism
(4) parasitism.

NEET-II 2016

47. The principle of competitive exclusion was stated by
(1) C. Darwin
(2) G.F. Gause
(3) Mac Arthur
(4) Verhulst and Pearl.

NEET-I 2016

48. When does the growth rate of a population following the logistic model equal zero? The logistic model is given as dN/dt = rN(1-N/K)
(1) when N/K equals zero
(2) when death rate is greater than birth rate
(3) when N/K is exactly one
(4) when N nears the carrying capacity of the habitat.

NEET-I 2016

49. Gause's principle of competitive exclusion states that
(1) no two species can occupy the same niche indefinitely for the same limiting resources
(2) larger organisms exclude smaller ones through competition
(3) more abundant species will exclude the less abundant species through competition
(4) competition for the same resources exclude species having different food preferences.

2015

50. An association of individuals of different species living in the same habitat and having functional interactions is
(1) ecosystem
(2) population
(3) ecological niche
(4) biotic community.

2015 Cancelled

51. Most animals are tree dwellers in a
(1) temperate deciduous forest
(2) tropical rainforest
(3) coniferous forest
(4) thorn woodland.

2015

52. In which of the following interactions both partners are adversely affected?
(1) Parasitism
(2) Mutualism
(3) Competition
(4) Predation

2015 Cancelled

53. The following graph depicts changes in two populations (A and B) of herbivores in a grassy field. A possible reason for these changes is that

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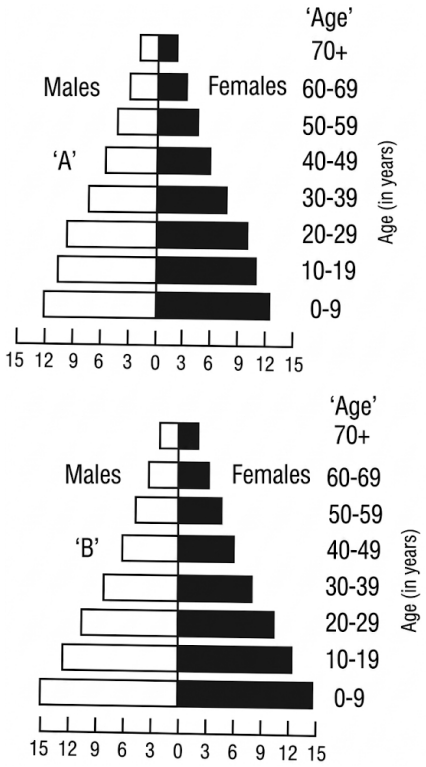
2009

72. A country with a high rate of population growth took measures to reduce it. The figure below shows age-sex pyramids of populations A and B twenty years apart. Select the correct interpretation about them.



Interpretations:

(1) "B" is earlier pyramid and shows stabilized growth rate.
(2) "B" is more recent showing that population is very young.
(3) "A" is the earlier pyramid and no change has occurred in the growth rate.
(4) "A" is more recent and shows slight reduction in the growth rate.

2008

73. Consider the following four statements (1-4) about certain desert animals such as kangaroo, rat.

(1) They have dark colour and high rate of reproduction and excrete solid urine.
(2) They do not drink water, breathe at a slow rate to conserve water and have their body covered with thick hairs.
(3) They feed on dry seeds and do not require drinking water.
(4) They excrete very concentrated urine and do not use water to regulate body temperature.

Which two of the above statements for such animals are true?

(1) 3 and 1 (2) 1 and 2
(3) 3 and 4 (4) 2 and 3

2008

74. Quercus species are the dominant component in

(1) scrub forests
(2) tropical rainforests
(3) temperate deciduous forests
(4) alpine forests.

2007

75. Geometric representation of age structure is a characteristic of

(1) population
(2) landscape
(3) ecosystem
(4) biotic community.

2007

76. The population of an insect species shows an explosive increase in numbers during rainy season followed by its disappearance at the end of the season. What does this show?

(1) The food plants mature and die at the end of the rainy season.
(2) Its population growth curve is of J-type.
(3) The population of its predators increases enormously.
(4) S-shaped or sigmoid growth of this insect.

2007

77. If the mean and the median pertaining to a certain character of a population are of the same value, the following is most likely to occur

(1) a bi-modal distribution
(2) a T-shaped curve
(3) a skewed curve
(4) a normal distribution.

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2007

78. A high density of elephant population in an area can result in

(1) intraspecific competition
(2) interspecific competition
(3) predation on one another
(4) mutualism.

2006

79. Niche overlap indicates

(1) mutualism between two species
(2) active cooperation between two species
(3) two different parasites on the same host
(4) sharing of one or more resources between the two species.

2011

64. Large woody vines are more commonly found in
(1) temperate forests
(2) mangroves
(3) tropical rainforests
(4) alpine forests.

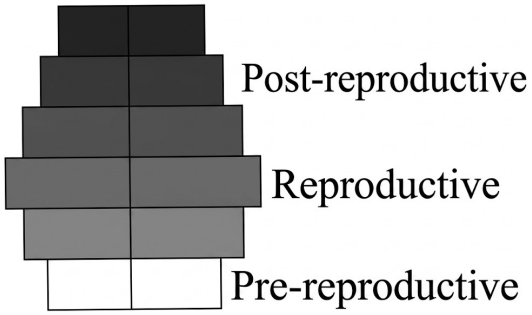
2011

65. Consider the following four conditions (1 - 4) and select a correct pair of them as adaptations to environment in desert lizards.
Conditions:
1. Burrowing in soil to escape high temperature.
2. Losing heat rapidly from the body during high temperature.
3. Bask in sun when temperature is low.
4. Insulating body due to thick fatty dermis.

(1) 3, 4
(2) 1, 3
(3) 2, 4
(4) 1, 2

2011

66. What type of human population is represented by the following age pyramid?



(1) Vanishing population
(2) Stable population
(3) Declining population
(4) Expanding population

2011

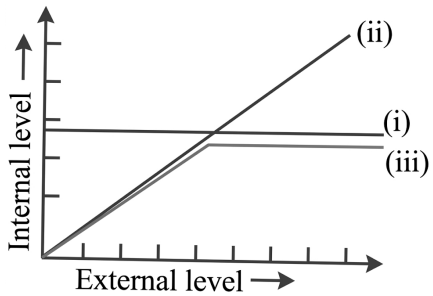
67. Which one of the following is categorised as a parasite in true sense?
(1) The female Anopheles bites and sucks blood from humans.
(2) Human fetus developing inside the uterus draws nourishment from the mother.
(3) Head louse living on the human scalp as well as laying eggs on human hair.
(4) The cuckoo (koel) lays its eggs in crow's nest.

Mains 2011

68. The logistic population growth is expressed by the equation
(1) dt/dN = Nr[(K-N)/K]
(2) dN/dt = rN[(K-N)/K]
(3) dN/dt = rN
(4) dN/dt = rN[(N-K)/N]

2010

69. The figure given below is a diagrammatic representation of response of organisms to abiotic factors. What do (i), (ii) and (iii) represent respectively?



(1) (i)-Conformer; (ii)-Regulator; (iii)-Partial regulator
(2) (i)-Regulator; (ii)-Partial regulator; (iii)-Conformer
(3) (i)-Partial regulator; (ii)-Regulator; (iii)-Conformer
(4) (i)-Regulator; (ii)-Conformer; (iii)-Partial regulator

Mains 2010

70. Which one of the following is most appropriately defined?
(1) Host is an organism which provides food to another organism.
(2) Amensalism is a relationship in which one species is benefitted whereas the other is unaffected.
(3) Predator is an organism that catches and kills other organism for food.
(4) Parasite is an organism which always lives inside the body of other organism and may kill it.

2009

71. Reduction in vascular tissue, mechanical tissue and cuticle is characteristic of
(1) mesophytes
(2) epiphytes
(3) hydrophytes
(4) xerophytes.

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2021

28. Inspite of interspecific competition in nature, which mechanism the competing species might have evolved for their survival?
(1) Predation
(2) Resource partitioning
(3) Competitive release
(4) Mutualism

2021

29. Amensalism can be represented as
(1) Species A (+) ; Species B (0)
(2) Species A (-) ; Species B (0)
(3) Species A (+) ; Species B (+)
(4) Species A (-) ; Species B (-).

2021

30. In the exponential growth equation $Nt = N_0e^{rt}$, e represents
(1) the base of geometric logarithms
(2) the base of number logarithms
(3) the base of exponential logarithms
(4) the base of natural logarithms.

2020

31. Which of the following is not an attribute of a population?
(1) Sex ratio
(2) Natality
(3) Mortality
(4) Species interaction

Odisha NEET 2019

32. Carnivorous animals lions and leopards, occupy the same niche but lions predate mostly larger animals and leopards take smaller ones. This mechanism of competition is referred to as
(1) character displacement
(2) altruism
(3) resource partitioning
(4) competitive exclusion.

Odisha NEET 2019

33. Between which among the following, the relationship is not an example of commensalism?
(1) Orchid and the tree on which it grows
(2) Cattle Egret and grazing cattle
(3) Sea Anemone and Clown fish
(4) Female wasp and fig species

2018

34. Niche is
(1) all the biological factors in the organism's environment
(2) the physical space where an organism lives
(3) the range of temperature that the organism needs to live
(4) the functional role played by the organism where it lives.

2018

35. Pneumatophores occur in
(1) halophytes
(2) free-floating hydrophytes
(3) carnivorous plants
(4) submerged hydrophytes.

2018

36. Natality refers to
(1) death rate
(2) birth rate
(3) number of individuals leaving the habitat
(4) number of individuals entering a habitat.

2018

37. Which one of the following plants shows a very close relationship with a species of moth, where none of the two can complete its life cycle without the other?
(1) Hydrilla (2) Yucca
(3) Banana (4) Viola

2018

38. In a growing population of a country,
(1) pre-reproductive individuals are more than the reproductive individuals
(2) reproductive individuals are less than the post-reproductive individuals
(3) reproductive and pre-reproductive individuals are equal in number
(4) pre-reproductive individuals are less than the reproductive individuals.

2018

39. Which one of the following population interactions is widely used in medical science for the production of antibiotics?
(1) Commensalism
(2) Mutualism
(3) Parasitism
(4) Amensalism

2017

40. Plants which produce characteristic pneumatophores and show vivipary belong to
(1) halophytes
(2) psammophytes
(3) hydrophytes
(4) mesophytes.

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2006

80. People living at sea level have around 5 million RBC per cubic millimeter of their blood whereas those living at an altitude to 5400 metres have around 8 million. This is because at high altitude
(1) people eat more nutritive food, therefore more RBCs are formed
(2) people get pollution-free air to breath and more oxygen is available
(3) atmospheric O_2 level is less and hence more RBCs are needed to absorb the required amount of O_2 to survive
(4) there is more UV radiation which enhances RBC production.

2006

81. Annual migration does not occur in the case of
(1) arctic tern
(2) salmon
(3) siberian crane
(4) salamander.

2006

82. Praying mantis is a good example of
(1) camouflage
(2) mullerian mimicry
(3) warning colouration
(4) social insects.

2005

83. More than 70% of world's freshwater is contained in
(1) polar ice
(2) glaciers and mountains
(3) Antarctica
(4) Greenland.

2005

84. At which latitude, heat gain through insolation approximately equals heat loss through terrestrial radiation?
(1) 22 1/2° North and South
(2) 40° North and South
(3) 42 1/2° North and South
(4) 66° North and South

2005

85. Animals have the innate ability to escape from predation. Examples for the same are given below. Select the incorrect example.
(1) Colour change in Chamaeleon
(2) Enlargement of body size by swallowing air in puffer fish
(3) Poison fangs in snakes
(4) Melanism in moths

2005

86. Which one of the following pairs is mismatched?
(1) Tundra - Permafrost
(2) Savanna - Acacia trees
(3) Prairie - Epiphytes
(4) Coniferous forest - Evergreen trees

2004

87. In which one of the following pairs is the specific characteristic of a soil not correctly matched?
(1) Laterite - Contains aluminium compound
(2) Terra rosa - Most suitable for roses
(3) Chernozems - Richest soil in the world
(4) Black soil - Rich in calcium carbonate

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2004

88. In which one of the following habitats does the diurnal temperature of soil surface vary most?
(1) Shrub land
(2) Forest
(3) Desert
(4) Grassland

2004

89. Certain characteristic demographic features of developing countries are
(1) high fertility, low or rapidly falling mortality rate, rapid population growth and a very young age distribution
(2) high fertility, high density, rapidly rising mortality rate and a very young age distribution
(3) high infant mortality, low fertility, uneven population growth and a very young age distribution
(4) high mortality, high density, uneven population growth and a very old age distribution.

2004

90. What is a keystone species?
(1) A species which makes up only a small proportion of the total biomass of a community, yet has a huge impact on the community's organization and survival.
(2) A common species that has plenty of biomass, yet has a fairly low impact on the community's organization.
(3) A rare species that has minimal impact on the biomass and on other species in the community
(4) A dominant species that constitutes a large proportion of the biomass and which affects many other species.

2004

91. The maximum growth rate occurs in
(1) stationary phase
(2) senescent phase
(3) lag phase
(4) exponential phase.

2003

92. Mycorrhiza is an example of
(1) symbiotic relationship
(2) ectoparasitism
(3) endoparasitism
(4) decomposers.

2003, 1998

93. Two opposite forces operate in the growth and development of every population. One of them is related to the ability to reproduce at a given rate. The force opposite to it is called
(1) fecundity
(2) environmental resistances
(3) biotic control
(4) mortality.

2002

94. Cause of mimicry is
(1) concealment (2) offence
(3) defence (4) both (b) and (c).

2002

95. What is true for individuals of same species?
(1) Live in same niche
(2) Live in same habitat
(3) Interbreeding
(4) Live in different habitat

2002

96. Which type of association is found in between entomophilous flower and pollinating agent?
(1) Mutualism
(2) Commensalism
(3) Co-operation
(4) Co-evolution

2002

97. Two different species cannot live for long duration in the same niche or habitat. This law is
(1) Allen's law
(2) Gause's hypothesis
(3) Dollo's rule
(4) Weismann's theory.

2002

98. In a population, unrestricted reproductive capacity is called as
(1) biotic potential
(2) fertility rate
(3) carrying capacity
(4) birth rate.

2001

99. In which of the following plant sunken stomata are found?
(1) Nerium
(2) Hydrilla
(3) Mango
(4) Guava

1999

100. Which part of the world has a high density of organisms?
(1) Deciduous forests
(2) Tropical rainforests
(3) Grasslands
(4) Savannah

1998

101. In desert grasslands, which type of animals are relatively more abundant?
(1) Aquatic
(2) Fossorial
(3) Diurnal
(4) Arboreal

1998

102. Plants such as Prosopis, Acacia and Capparis represent examples of tropical
(1) deciduous forests
(2) evergreen forests
(3) grasslands
(4) thorn forests.

1998

103. Which of the following communities is more vulnerable to invasion by outside animals and plants?
(1) Temperate forests
(2) Oceanic island communities
(3) Mangroves
(4) Tropical evergreen forests

1998

104. An interesting modification of flower shape for insect pollination occurs in some orchids in which a male insect mistakes the pattern on the orchid flower for the female species and tries to copulate with it, thereby pollinating the flower. This phenomenon is called
(1) pseudopollination
(2) pseudoparthenocarpy
(3) mimicry
(4) pseudocopulation.

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1997

105. During adverse season, therophytes survive by
(1) rhizomes
(2) seeds
(3) bulbs
(4) corms

1996

106. Benthic animals are those, which
(1) are submerged in area
(2) float on the sea surface
(3) are deep dweller in sea
(4) are floating (free) organisms.

1996

107. The 'niche' of a species is meant for
(1) habitat and specific functions of a species
(2) specific place where an organism lives
(3) specific species function and its competitive power
(4) none of these.

1996

108. The animals of cold countries have relatively shorter and poorly developed ears, eyes, hairs and other phenotypic characters. This is known by which law?
(1) Cope's Law
(2) Dollo's Law
(3) Allen's Law
(4) Bergamann's Law

1995

109. The abundance of a species population, within its habitat, is called
(1) relative density
(2) regional density
(3) absolute density
(4) niche density.

1995

110. Which one of the following pairs is correctly matched?
(1) Parasitism - intraspecific relationship
(2) Uricotelism - aquatic habitat
(3) Excessive perspiration - xeric adaptation
(4) Streamlined body - aquatic adaptation

1994

111. Mycorrhiza exhibits the phenomenon of
(1) parasitism
(2) symbiosis
(3) antagonism
(4) endemism.

1993

112. Study of inter-relationships between organisms and their environment is
(1) ecology
(2) ecosystem
(3) phytogeography
(4) ethology.

1993

113. The sum total of the populations of the same kind of organisms constitute
(1) colony
(2) genus
(3) community
(4) species.

1993

114. Association of animals when both partners are benefitted
(1) colony
(2) mutualism
(3) commensalism
(4) ammensalism.

1992

115. Fertility of soil is measured by its ability to
(1) retain nutrients
(2) hold organic materials
(3) hold water
(4) support life.

1992

116. Soil particles determine its
(1) texture
(2) field capacity
(3) water holding capacity
(4) soil flora.

1991

117. Homeostasis is
(1) tendency of biological systems to change with change in environment
(2) tendency of biological systems to resist change
(3) disturbance of self regulatory system and natural controls
(4) biotic materials used in homeopathic medicines.

1991

118. Deep black soil is productive due to high proportion of
(1) sand and zinc
(2) gravel and calcium
(3) clay and humus
(4) silt and earthworm.

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births and immigrants exceeds the total number of deaths and individuals leaving the area.

11. (4) A-II, B-III, C-IV, D-I
Biological interactions vary significantly across different species. Predators like Pisaster maintain diversity by controlling prey populations. Mutualism is seen in the obligate relationship between fig trees and wasps. Parasitism involves organisms like Plasmodium that depend on hosts for survival. Sexual deceit is a unique strategy used by the orchid Ophrys, which mimics female insects to ensure pollination by males.

12. (2) A-IV, B-I, C-II, D-III
Interspecific competition occurs between different species for shared resources, like flamingos and fish. Interference competition is seen when the presence of one species, such as goats, leads to the extinction of another. Competitive release happens when a species expands its range after a competitor is removed. Resource partitioning allows species to coexist by utilizing different feeding times or locations.

13. (1) 'a' represents exponential growth when responses are not limiting the growth; and 'b' represents logistic growth when responses are limiting the growth.
Population growth curves typically follow two patterns based on resource availability. Curve 'a' represents exponential growth, occurring when resources are unlimited and environmental resistance is absent. Curve 'b' depicts logistic growth, where the growth rate slows down as the population density approaches the carrying capacity of the habitat. This sigmoid pattern reflects more realistic conditions where resources are finite.

14. (3) carrying capacity
In the Verhulst-Pearl logistic growth equation, the constant K represents the carrying capacity of a given environment. This value signifies the maximum number of individuals of a particular species that a habitat can support indefinitely based on available resources like food and space. When the population size reaches this limit, the growth rate becomes zero, resulting in a stabilized population.

15. (4) Statement I is false but Statement II is true.
Gause's competitive exclusion principle states that two closely related species competing for the same limiting resources cannot coexist indefinitely. The competitively inferior species will eventually be eliminated. However, if resources are not limiting or species evolve different resource-use strategies, they might coexist. Therefore, the principle specifically applies when species compete for identical resources rather than different ones, making resource limitation crucial.

16. (4) mutualism.
Mutualism is a symbiotic relationship where both participating species derive benefits from their interaction. In the context of pollination, plants provide rewards such as nectar and pollen which serve as food sources for animals. In return, the animals assist in the transfer of pollen grains between flowers, facilitating plant reproduction. This interdependent relationship is essential for the survival of both groups.

17. (2) 9
The birth rate is calculated by dividing the number of new individuals produced by the initial population size during a specific time period. In this scenario, the population increased by 2250 individuals from an initial count of 250 snails. Dividing 2250 by the original 250 snails results in a birth rate of exactly nine offspring per snail per year in the pond.

18. (1) cardiac glycosides
Many plants have evolved chemical defenses to protect themselves from herbivory. Calotropis produces highly poisonous cardiac glycosides, which are toxic to the heart of most animals that attempt to consume it. This chemical deterrent prevents cattle and goats from grazing on these plants. Such specialized adaptations ensure the survival of the species in environments where grazing pressure from various herbivores is high.

19. (4) A-IV, B-I, C-II, D-III
Biological interactions are categorized based on their effects on the participating species. Mutualism is beneficial for both partners. Commensalism benefits one species while the other remains unaffected. Amensalism is characterized by one species being harmed while the other is neither helped nor hindered. Parasitism involves a situation where one organism, the parasite, benefits at the direct and detrimental expense of the host.

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ANSWERS

1. (2) A-III, B-I, C-II, D-IV
Both species harmed = competition (III). One harmed and one benefited = predation (I). Both benefit = mutualism (II). One benefits, other unaffected = commensalism (IV). This gives A-III, B-I, C-II, D-IV.

2. (1) 10 million
The intrinsic rate of natural increase (r) = birth rate - death rate = 0.002 - 0.002 = 0. When r = 0, the population neither grows nor declines and remains constant. Hence the number of cells stays at 10 million.

3. (3) Both A and R are correct and R is the correct explanation of A
The logistic model is more realistic (A correct) because it accounts for carrying capacity. Since natural resources are finite (R correct), populations cannot grow exponentially forever and stabilise near carrying capacity. Thus limited resources explain why logistic growth is realistic.

4. (2) $dN/dt = rN ((K-N)/K)$
The Verhulst-Pearl logistic growth equation is $dN/dt = rN[(K-N)/K]$,
Where, N is population size, r is intrinsic growth rate, and K is carrying capacity. The factor $(K-N)/K$ represents environmental resistance, giving a sigmoid (S-shaped) growth curve as the population approaches carrying capacity.

5. (3) B, D and E only
In mutualism both species benefit (B correct). In parasitism only the parasite benefits while the host is harmed (D correct). In amensalism one species is harmed and the other is unaffected (E correct). Statement A is wrong because commensalism does not harm either species, and C is wrong about commensalism.

6. (4) Ramdeo Misra
Professor Ramdeo Misra is widely recognized for his pioneering contributions to the field of ecology in the Indian subcontinent. He established the Department of Botany at Banaras Hindu University and initiated research on plant ecology and succession. His extensive work on tropical forest ecosystems and environmental conservation helped in shaping the ecological curriculum and research framework throughout modern India.

7. (4) $dN/dt = rN[(K-N)/K]$
The logistic growth model describes how a population grows in an environment with limited resources. In this equation, N represents population density at time t, r is the intrinsic rate of natural increase, and K stands for the carrying capacity. The term in the parentheses accounts for environmental resistance, ensuring that the growth rate slows as the population reaches its limit.

8. (3) Commensalism
Commensalism is an interspecific interaction where one species benefits while the other remains unaffected. Epiphytic plants, such as orchids, grow on the branches of trees like mango for structural support and access to sunlight. While the epiphyte gains a better position for photosynthesis, the mango tree does not derive any benefit nor does it suffer any significant harm from this.

9. (2) Statement I is incorrect but statement II is correct.
The relationship between the fig tree and its pollinator wasp is a classic example of mutualism. The wasp uses the fruit as an oviposition site and for larval nourishment, while simultaneously pollinating the flowers. Although the fruit may contain developing larvae, it is biologically classified as a plant product. Therefore, the assertion regarding its non-vegetarian nature is scientifically inaccurate.

10. (4) births plus number of immigrants is more than the sum of number of deaths and number of emigrants.
Population density is influenced by four primary factors: natality, mortality, immigration, and emigration. Natality and immigration contribute to an increase in the number of individuals within a specific habitat. Conversely, mortality and emigration lead to a decrease. Therefore, density increases when the combined sum of

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impacted species and a zero for the neutral participant. An example includes the production of antibiotic substances by fungi, which kills bacteria without providing any immediate benefit or harm to the fungus.

30. (4) the base of natural logarithms.
In the mathematical formula for exponential population growth, the symbol 'e' represents the base of natural logarithms. Its value is approximately two point seven one eight. This constant is used to calculate the population size at any given time when growth is continuous and unimpeded by limiting factors. It is essential for modeling how populations expand rapidly.

31. (4) Species interaction
Population attributes are characteristics that apply to a group of individuals of the same species as a whole, rather than to a single organism. Key attributes include natality, mortality, sex ratio, and population density. While species interactions like predation or competition occur within a community involving multiple populations, they are not considered intrinsic properties of a single population's demographic structure.

32. (3) resource partitioning
Resource partitioning occurs when species with similar niches evolve different patterns of resource usage to reduce competition. By preying on different sized animals, lions and leopards can coexist in the same geographic area. This behavioral adaptation allows them to share the available food resources without one species driving the other to extinction, thereby maintaining the overall stability and diversity.

33. (4) Female wasp and fig species
Commensalism involves one species benefiting while the other is unaffected. Orchids on trees, cattle egrets with cattle, and clownfish with sea anemones are classic examples. However, the relationship between female wasps and fig trees is mutualistic. Both species depend on each other for reproduction; the wasp pollinates the fig while the fig provides a safe site and food for the larvae.

34. (4) the functional role played by the organism where it lives.
An ecological niche refers to the unique functional role and position a species occupies within its habitat. It encompasses all the interactions of the species with the biotic and abiotic factors of its environment. This includes its nutritional requirements, reproductive patterns, and how it utilizes resources. Unlike a habitat, which is simply a location, a niche defines exactly how an organism lives.

35. (1) halophytes
Halophytes are plants that grow in saline environments, such as mangrove swamps, where the soil is often waterlogged and anaerobic. To obtain necessary oxygen for root respiration, these plants develop specialized vertical roots called pneumatophores. These structures grow upwards out of the soil and water, possessing small pores called lenticels that facilitate gas exchange between the atmosphere and root system.

36. (2) birth rate
Natality is a demographic term used in population ecology to describe the birth rate within a population over a specific period. It represents the number of new individuals added to the population through reproduction. This factor, along with mortality, immigration, and emigration, determines the overall growth and density of a population within its natural habitat or in a controlled environment.

37. (2) Yucca
The Yucca plant and the moth share an obligate mutualistic relationship where neither can complete its life cycle independently. The moth serves as the exclusive pollinator for the Yucca flowers. In exchange, the moth deposits its eggs within the ovary of the flower. The developing larvae then feed on some of the seeds, while the remaining seeds ensure the plant's reproduction.

38. (1) pre-reproductive individuals are more than the reproductive individuals
In a growing or expanding population, the age-sex pyramid typically has a broad base. This indicates that the number of pre-reproductive individuals, such as children and adolescents, is significantly higher than the number of individuals in the reproductive age group. As these younger individuals mature and reach reproductive age, the population size will continue to increase rapidly over successive generations.

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20. (1) Statement I is correct but Statement II is false.
Gause's principle highlights that two species competing for the same limiting resources cannot coexist. The competitively inferior one is eventually eliminated. However, it is generally observed that herbivores and plants are more adversely affected by competition than carnivores. This is because carnivores often have more flexible hunting strategies or larger territories, whereas herbivores are often limited by specific plant distributions.

21. (3) A-II, B-I, C-III, D-IV
Logistic growth occurs under limited resource conditions, while exponential growth happens when resources are unlimited. Age pyramids reflect the demographic status of a population. An expanding pyramid has a very high proportion of pre-reproductive individuals. In contrast, a stable population is characterized by having roughly equal proportions of individuals in the pre-reproductive and reproductive age groups, resulting in zero growth.

22. (3) A-I, B-II, C-III, D-IV
Competition occurs between predators like lions and leopards for common prey. Brood parasitism is seen when cuckoos lay eggs in crow nests. Mycorrhizae represent a mutualistic association between fungi and plant roots. Commensalism is illustrated by cattle egrets feeding near grazing cattle. These diverse interactions shape the structure of ecological communities and influence the survival and reproduction of various species.

23. (3) Both the interacting species are negatively impacted.
Predation is a biological interaction where the predator benefits by consuming the prey, which is harmed. This relationship is essential for maintaining ecological balance and species diversity by preventing any single prey species from becoming dominant. While it can lead to the extinction of vulnerable prey under certain conditions, it never involves a situation where both interacting species are negatively affected.

24. (1) Predation
Interspecific interactions are defined by the positive, negative, or neutral effects they have on participants. Predation is a classic example of an interaction where the predator derives nutritional benefit and the prey is killed. Parasitism also follows this pattern. In contrast, competition is usually harmful for both, commensalism is neutral for one, and amensalism involves one species being unharmed.

25. (1) 0.1
The death rate in a population is determined by dividing the total number of individuals that died during a specific interval by the initial population size. In this instance, eight Drosophila died out of an original group of eighty. Performing the calculation eight divided by eighty yields a death rate of zero point one individuals per Drosophila per week in the laboratory.

26. (4) (iv) (i) (ii) (iii)
Adaptations allow organisms to survive in specific environments. Allen's rule states that mammals from colder climates have shorter ears and limbs, as seen in polar seals. Physiological adaptations, like water conservation in kangaroo rats, help in arid zones. Behavioral adaptations include desert lizards basking in the sun. Biochemical adaptations enable marine fish to withstand extreme pressures at great ocean depths.

27. (2) Both (A) and (R) are true and (R) is the correct explanation of (A).
Altitude sickness occurs when individuals travel to high elevations where the atmospheric pressure is significantly lower. This reduction in pressure decreases the availability of oxygen to the body's tissues. Consequently, the body experiences symptoms like breathing difficulties and heart palpitations as it struggles to maintain homeostasis. The physiological response involves increasing red blood cell production and decreasing hemoglobin's oxygen-binding affinity.

28. (2) Resource partitioning
To avoid competitive exclusion, species competing for the same resources may evolve mechanisms to coexist. Resource partitioning is a strategy where species use different parts of a habitat, different types of food, or feed at different times. This reduces the direct competition between them, allowing multiple species to survive in the same area without one being completely eliminated.

29. (2) Species A (-) ; Species B (0)
Amensalism is a type of interspecific interaction where one species is harmed or inhibited while the other species remains unaffected. This is represented by a minus sign for the negatively

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1991

119. Homeostasis is
(1) tendency to change with change in environment
(2) tendency to resist change
(3) disturbance in regulatory control
(4) plants and animal extracts used in homeopathy.

1991

120. Which one is true?
(1) Commensalism when none of the interacting populations affect each other.
(2) Symbiosis when the interaction is useful to both the populations.
(3) Symbiosis when neither populations affects each other.
(4) Commensalism when the interaction is useful to both the populations.

1989

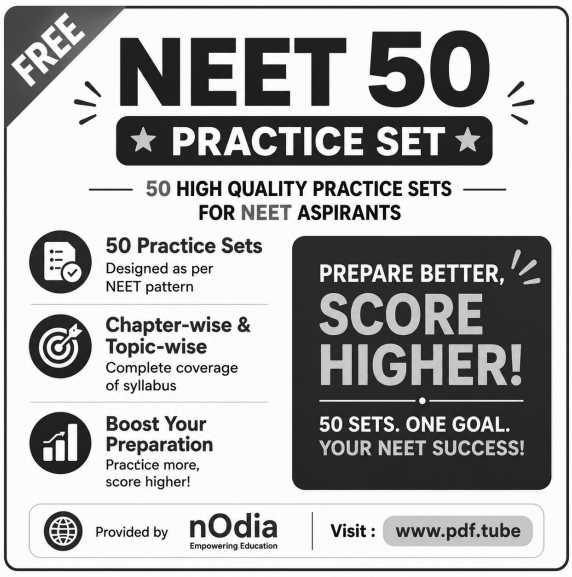
121. The relation between algae and fungi in a lichen is
(1) symbiosis
(2) parasitism
(3) commensalism
(4) protocooperation.

1988

122. A mutually beneficial association necessary for survival of both partners is
(1) mutualism/symbiosis
(2) commensalism
(3) amensalism
(4) both (a) and (b).

1988

123. Competition for light, nutrients and space is most severe between
(1) closely related organism growing in different niches
(2) closely related organisms growing in the same area/niche
(3) distantly related organisms growing in the same habitat
(4) distantly related organisms growing in different niches.



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39. (4) Amensalism
Amensalism is a biological interaction where one organism is inhibited or destroyed while the other remains unaffected. This principle is extensively utilized in medical science for producing antibiotics. For example, the fungus Penicillium produces penicillin, which inhibits the growth of various bacteria. The fungus does not benefit directly from killing the bacteria, but this chemical secretion is crucial for medical treatments.

40. (1) halophytes
Halophytes are plants specifically adapted to survive in saline and waterlogged soils, such as those found in mangrove forests. They exhibit unique features like pneumatophores, which are respiratory roots that grow above the mud to facilitate gas exchange. Additionally, many halophytes show vivipary, where seeds germinate while still attached to the parent plant, helping seedlings establish in challenging environments.

41. (1) tropical rainforest
Tropical rainforests exhibit the most complex and well-defined vertical stratification among all terrestrial biomes. This arrangement occurs because plants of different heights, including tall emergent trees, a dense canopy, undergrowth shrubs, and ground vegetation, organize themselves to maximize sunlight absorption. This multi-layered structure supports an incredibly high level of biodiversity by creating numerous microhabitats for a wide variety of species.

42. (1) K = N
In a logistic growth curve, which follows a sigmoid or S-shaped pattern, an asymptote is reached when the population density equals the carrying capacity of the environment. At this point, the resources become limiting, and the number of births roughly equals the number of deaths. Consequently, the population size stabilizes, and the growth rate becomes zero, represented by a horizontal line.

43. (3) mutualism
Mycorrhizae represent a symbiotic association between fungal hyphae and the roots of higher plants. This relationship is an example of mutualism because both organisms benefit. The fungus increases the surface area for water and nutrient absorption, particularly phosphorus, from the soil. In exchange, the plant provides the fungus with organic compounds like carbohydrates produced during photosynthesis, which the fungus requires.

44. (4) smaller animals have a higher metabolic rate.
Smaller animals have a higher surface area to volume ratio compared to larger animals, which leads to more rapid heat loss. To compensate, they possess a much higher metabolic rate. This increased metabolism allows them to generate energy more quickly, making it easier for them to perform strenuous physical activities, such as running uphill, despite the mechanical energy required for climbing.

45. (1) Large number of progeny with small size
The concept of r-selection refers to organisms that prioritize high growth rates and maximize reproductive output. These species typically inhabit unstable or unpredictable environments. Consequently, they produce a large number of offspring, but each individual is small in size and receives minimal parental care. This strategy increases the probability that at least some progeny will survive to maturity despite high mortality.

46. (4) parasitism.
A population interaction labeled as positive for one and negative for the other indicates that one species benefits while the other is adversely affected. Parasitism is a prime example of this dynamic, where the parasite derives nourishment and shelter from the host, often causing harm or disease. This is similar to predation, where the predator benefits and the prey is killed.

47. (2) G.F. Gause
The principle of competitive exclusion was formulated by the Russian ecologist G.F. Gause. It states that two species competing for the exact same limiting resources cannot coexist indefinitely in the same niche. Eventually, the more efficient competitor will outcompete and eliminate the other. This concept is fundamental in understanding how species distribution and community structure are shaped by resource availability and competition.

48. (3) when N/K is exactly one
In the logistic growth equation, the term representing environmental resistance is calculated using the ratio of population density to carrying capacity. When this ratio equals

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exactly one, the population has reached its carrying capacity. Subtracting this from one results in zero, which makes the entire growth rate equation equal to zero. This signifies that the population has stopped growing and reached stability.

49. (1) no two species can occupy the same niche indefinitely for the same limiting resources
Gause's principle of competitive exclusion posits that two species with identical niche requirements cannot coexist indefinitely when resources are limited. The species that utilizes the resources more efficiently will ultimately drive the other to local extinction. This principle underscores the importance of niche differentiation and resource partitioning in allowing diverse species to inhabit the same general area without constant direct competition.

50. (4) biotic community.
A biotic community consists of populations of different species that live together in a common habitat and interact with one another. These functional interactions can include competition, predation, and mutualism. Unlike an ecosystem, which includes both living organisms and their physical environment, a community focuses specifically on the complex network of relationships among the various biological entities within a given area.

51. (2) tropical rainforest
Tropical rainforests are characterized by high rainfall, warm temperatures, and dense vegetation with multiple vertical layers. Because the ground level is often dark and crowded, many animal species have adapted to live in the trees. These arboreal animals, including various primates, birds, and insects, find abundant food, shelter, and protection within the complex canopy and understory layers of this biome.

52. (3) Competition
Competition is an interspecific interaction where both species are negatively impacted because they are vying for the same limited resources, such as food, water, or territory. Even the "winner" of the competition experiences costs in terms of energy expenditure or injury. This contrasts with other interactions like mutualism, where both benefit, or predation and parasitism, where one benefits and one suffers.

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53. (4) population B competed more successfully for food than population A.
When two populations of herbivores occupy the same field and compete for identical food sources, their population dynamics often reflect their competitive abilities. If the population of one species increases while the other decreases, it suggests that the former is a more efficient competitor. According to Gause's principle, the superior competitor will eventually dominate the available resources and habitat in that ecosystem.

54. (4) Keoladeo National Park.
During the harsh winter months, many birds migrate from the extremely cold regions of Siberia and Northern Asia to warmer climates. A famous destination in India for these migratory species is Keoladeo National Park, located in Rajasthan. This wetland ecosystem provides a suitable habitat and abundant food, serving as a vital wintering ground for thousands of birds, including the Siberian crane.

55. (3) Loss of reproductive capacity
Parasites have evolved various specialized adaptations to survive and thrive within or on their hosts. These include the development of adhesive organs like suckers, the loss of unnecessary sense organs, and the reduction of digestive systems. However, parasites typically have very high reproductive capacities to ensure their complex life cycles continue, making the loss of reproductive ability an incorrect adaptation choice.

56. (3) sediment characteristics of aquatic ecosystems
Benthic organisms are those that live on or within the bottom sediments of aquatic environments like oceans, lakes, and rivers. Their distribution and survival are primarily determined by the physical and chemical characteristics of the sediment, such as grain size and mineral composition. These factors influence the type of shelter, food availability, and substrate stability for the entire bottom-dwelling community.

57. (4) interspecific competition.
Charles Darwin proposed that organic evolution is largely driven by natural selection, which often arises from intense competition among organisms. While he recognized various forms of struggle, interspecific competition—the struggle between different species for limited resources—

plays a crucial role. This competition favors individuals with advantageous traits, leading to their survival and reproduction, and eventually resulting in the evolution of new species.

58. (4) Cycas.
Cyanobacteria, such as Anabaena and Nostoc, are known for their ability to fix atmospheric nitrogen. In addition to being found in paddy fields, they form symbiotic associations with certain plants. In Cycas, these bacteria reside within specialized coralloid roots. This partnership is beneficial as the cyanobacteria provide fixed nitrogen to the plant, while the plant provides a protected environment and nutrients.

59. (1) commensalism
The association between a sea anemone and a hermit crab is often cited as an example of commensalism. The sea anemone attaches itself to the shell occupied by the crab, gaining mobility and access to food particles left behind by the crab's feeding. While the anemone clearly benefits, the hermit crab is generally considered to be unaffected by the presence of it.

60. (2) zero
The net change in population size is calculated using the formula: (Natality plus Immigration) minus (Mortality plus Emigration). For this rat population, the sum of natality and immigration is two hundred seventy. The sum of mortality and emigration is also two hundred seventy. Subtracting these values results in a net increase of zero, meaning the population size remained exactly constant.

61. (4) high percentage of young individuals.
An age pyramid with a broad base indicates a population with a high proportion of young, pre-reproductive individuals. This structure is characteristic of a rapidly expanding population. As these young individuals eventually enter their reproductive years, they will contribute to a significant increase in the total population size, assuming that birth rates remain high and mortality rates are relatively low or declining.

62. (1) have more RBCs and their haemoglobin has a lower binding affinity to O_2
When people move to high altitudes, they experience lower oxygen levels. The body compensates for this through physiological adaptations. It increases the production of red blood cells to transport more oxygen. Simultaneously, the binding affinity of hemoglobin for oxygen decreases, which facilitates the more efficient release of oxygen into the body tissues where it is critically needed for sustaining basic metabolism.

63. (1) ectoparasitism
Cuscuta, commonly known as dodder, is a parasitic plant that lacks chlorophyll and cannot perform photosynthesis. It derives its nutrition by attaching itself to a host plant using specialized structures called haustoria. Since it lives on the external surface of the host and absorbs nutrients from the host's vascular system, it is classified as a total stem ectoparasite in the plant kingdom.

64. (3) tropical rainforests.
Large woody vines, known as lianas, are a prominent feature of tropical rainforests. These plants use the tall trees of the forest for structural support as they climb towards the canopy to reach sunlight. Their abundance is a result of the intense competition for light in the dense, multi-layered forest environment, where ground-level light is often insufficient for many species.

65. (2) 1, 3
Desert lizards exhibit behavioral adaptations to regulate their body temperature in extreme environments. When their body temperature drops below their comfort zone, they bask in the sun to absorb heat. Conversely, when the ambient temperature becomes excessively high, they move into the shade or burrow into the soil to escape the heat. These behaviors allow them to maintain a stable internal temperature.

66. (2) Stable population
An age pyramid that is bell-shaped with roughly equal proportions of pre-reproductive and reproductive individuals represents a stable population. In such a population, the number of individuals entering the reproductive phase is sufficient to replace those leaving it, leading to a growth rate that is near zero. This indicates that the population size is remaining relatively constant over time without significant expansion.

67. (3) Head louse living on the human scalp as well as laying eggs on human hair.
A true parasite is an organism that lives on or inside a host, deriving nourishment and causing

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rainfall. Epiphytes are typically found in humid environments like tropical rainforests, where they grow on other plants for support rather than in grasslands.

87. (2) Terra rosa - Most suitable for roses
Soil types have distinct properties; laterite is rich in aluminum, and chernozems are highly fertile, organic-rich soils. Black soil is known for its calcium carbonate and clay content. While terra rosa translates to red earth and is found in limestone regions, its name is not derived from its suitability for growing roses. It is actually well-suited for crops like grapes.

88. (3) Desert
Desert environments experience the most extreme diurnal temperature variations on the soil surface. During the day, the lack of cloud cover and vegetation allows the ground to absorb intense solar radiation, causing temperatures to soar. At night, the absence of moisture and insulating plants leads to rapid heat loss into the atmosphere. This results in a significant difference between daytime and nighttime.

89. (1) high fertility, low or rapidly falling mortality rate, rapid population growth and a very young age distribution
Developing countries often exhibit characteristic demographic features due to improving healthcare and high birth rates. These include high fertility rates and rapidly falling mortality rates, which lead to significant population growth. Consequently, these populations have a very young age distribution, represented by a pyramid with a very broad base. This demographic profile presents unique economic and social challenges for nations.

90. (1) A species which makes up only a small proportion of the total biomass of a community, yet has a huge impact on the community's organization and survival.
A keystone species is one that has a disproportionately large impact on its natural environment relative to its limited biomass or abundance. These species play a critical role in maintaining the structure and integrity of an ecological community. If a keystone species is removed, the ecosystem often undergoes dramatic changes or even collapse, as it affects many other organisms through complex interactions.

91. (4) exponential phase.
During the growth of a population, the maximum rate of increase occurs during the exponential or log phase. In this stage, resources are abundant, and environmental resistance is minimal, allowing the population to expand at its biotic potential. This phase follows the initial lag phase and precedes the stationary phase, where growth eventually slows down as resources become limited and carrying capacity is reached.

92. (1) symbiotic relationship
Mycorrhiza is a classic example of a symbiotic relationship between fungi and the roots of higher plants. The fungal partner assists the plant in absorbing water and essential minerals like phosphorus from the soil. In return, the plant provides the fungus with organic nutrients produced through photosynthesis. This interdependence is vital for the healthy growth and survival of many different plant species.

93. (2) environmental resistances
Every population has an innate biotic potential, which is the maximum rate at which it can reproduce under ideal conditions. However, this growth is limited by various external factors collectively known as environmental resistance. These factors include limited food, predation, and disease. The balance between the reproductive drive and environmental resistance determines the actual growth rate and size of any population.

94. (3) Interbreeding
The biological definition of a species is a group of individuals that are capable of interbreeding with one another to produce fertile offspring. While individuals of the same species often live in the same habitat and occupy the same niche, the most defining characteristic is their ability to exchange genetic material through reproduction. This maintains the distinct genetic identity of the specific species.

95. (4) both (b) and (c).
Mimicry is an evolutionary adaptation where one species resembles another species or an object. This phenomenon serves two primary purposes: offense and defense. In defensive mimicry, a harmless species avoids predation by looking like a toxic or dangerous one. In offensive mimicry, a predator mimics a harmless species or

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mass die-off of the population. This pattern is typical for many small, short-lived organisms.

77. (4) a normal distribution.
In statistics and population ecology, a normal distribution is characterized by a symmetric, bell-shaped curve. In this type of distribution, the mean, median, and mode all have the same value and are located at the center of the curve. This indicates that most individuals in the population possess the average value for a specific character, with fewer individuals having extreme values.

78. (1) intraspecific competition
Intraspecific competition occurs between members of the same species when they compete for limited resources like food, water, and space. A high density of individuals, such as elephants in a specific area, increases the demand for these resources. This can lead to reduced growth rates, lower reproductive success, and increased mortality as individuals struggle to obtain what they need from the environment.

79. (4) sharing of one or more resources between the two species.
Niche overlap occurs when two or more species utilize the same resources, such as food types, nesting sites, or feeding times, within a shared habitat. While a small amount of overlap may allow for coexistence, significant overlap often leads to intense competition. According to ecological principles, species with overlapping niches must either partition resources or one will ultimately outcompete the other.

80. (3) atmospheric O_2 level is less and hence more RBCs are needed to absorb the required amount of O_2 to survive
At high altitudes, the atmospheric pressure is lower, which results in a decrease in the partial pressure of oxygen. To ensure that the body's tissues receive an adequate supply of oxygen, the human body adapts by increasing the production of red blood cells. This higher concentration of cells enhances the blood's capacity to bind and transport the available oxygen to tissues.

81. (4) salamander.
Annual migration is a seasonal movement practiced by many species to find better feeding grounds or breeding sites. Birds like the Siberian crane and Arctic tern, and fish like salmon, are famous for their long-distance travels. However, most salamanders do not undertake such large-scale annual migrations. Instead, they typically remain within a relatively small home range, though they may move locally.

82. (1) camouflage
The praying mantis is a master of camouflage, an adaptation where an organism's appearance allows it to blend into its surroundings. By mimicking the color and shape of leaves or twigs, the mantis remains hidden from both its predators and its unsuspecting prey. This visual deception is a crucial survival strategy that enhances its hunting efficiency and provides protection in nature.

83. (1) polar ice
While the Earth is covered mostly by water, only a small fraction is freshwater. Over seventy percent of this freshwater is locked away in the form of polar ice caps and glaciers, primarily in Antarctica and Greenland. This vast reservoir of frozen water is unavailable for immediate human use but plays a critical role in regulating global temperatures and sea levels.

84. (2) 40° North and South
On a global scale, there is a balance between the incoming solar energy and the outgoing terrestrial radiation. At approximately forty degrees latitude in both the Northern and Southern Hemispheres, the amount of heat gained from the sun is roughly equal to the amount of heat lost to space. In tropical regions, gain exceeds loss, while in polar regions, loss exceeds gain.

85. (3) Poison fangs in snakes
Many animals have evolved mechanisms to escape from predators, such as camouflage in chameleons, body enlargement in puffer fish, and industrial melanism in moths. These are defensive strategies. However, poison fangs in snakes are primarily offensive tools used for subduing and killing prey, rather than an innate ability to escape from being eaten. Therefore, they are not an escape mechanism.

86. (3) Prairie - Epiphytes
Biomes are characterized by specific vegetation and environmental conditions. Tundra has permafrost, savannas feature acacia trees, and coniferous forests are dominated by evergreen trees. However, prairies are grasslands where trees and epiphytes are largely absent due to low

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dry summers, the adult plant dies off completely. These species survive as dormant seeds, which are highly resistant to extreme environmental conditions. When favorable conditions return, the seeds germinate, allowing the next generation of plants to grow and reproduce.

106. (3) are deep dweller in sea
Benthic animals are organisms that live at the bottom of a body of water, such as the ocean floor or a lake bed. These deep dwellers have adapted to unique conditions like high pressure, low light levels, and specialized food sources like detritus. Their lifestyle contrasts with pelagic organisms, which live in the open water, and planktonic organisms, which float or drift.

107. (1) habitat and specific functions of a species
The niche of a species encompasses both the physical habitat where it lives and the specific functional roles it performs within that environment. It includes how the organism obtains its nutrients, its reproductive strategies, and its interactions with other species. While a habitat is merely the location of a species, its niche is its role, defining its contribution to the ecosystem.

108. (3) Allen's Law
Allen's Law states that mammals from colder climates tend to have shorter limbs, ears, and other appendages compared to those from warmer regions. This morphological adaptation serves to minimize the surface area through which body heat can be lost. By reducing heat dissipation, these animals can maintain their internal body temperature more efficiently, which is crucial for survival in frigid environments.

109. (4) niche density.
Niche density refers to the abundance of a species population within its specific habitat or functional role in an ecosystem. It reflects how many individuals of a particular species are supported by the available resources in the niche they occupy. This measure is important for understanding the carrying capacity of an environment and the intensity of competition between species sharing similar resources.

110. (4) Streamlined body - aquatic adaptation
A streamlined body is a classic morphological adaptation for life in an aquatic environment. This shape reduces water resistance, allowing fish and other aquatic animals to move more efficiently through the dense medium. In contrast, parasitism is an interspecific relationship, uricotelism is an adaptation for water conservation, and excessive perspiration is a mechanism for cooling rather than a specific xeric adaptation.

111. (2) symbiosis
Mycorrhiza is a well-known example of symbiosis, specifically a mutualistic relationship between fungi and the roots of most vascular plants. The fungus provides the plant with improved access to water and essential nutrients, especially phosphorus. In return, the plant supplies the fungus with carbohydrates produced via photosynthesis. This mutually beneficial partnership is fundamental for the health and productivity of many ecosystems.

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112. (1) ecology
Ecology is the scientific study of the complex inter-relationships between living organisms and their physical and biological environment. It examines how organisms interact with each other and with abiotic factors such as climate, soil, and water. By understanding these interactions, ecologists can gain insights into the distribution and abundance of species, the flow of energy, and the cycling of nutrients.

113. (4) species.
In biological classification and ecology, a species is defined as a group of organisms that are capable of interbreeding and producing fertile offspring. The sum total of all individuals of the same kind living in a particular area at a given time constitutes a population. Understanding the dynamics of a species and its populations is essential for studying biodiversity and evolution.

114. (2) mutualism
Mutualism is a type of symbiotic interaction where both participating organisms derive benefits. These benefits can include nutrition, protection, or reproduction. Examples include the relationship between pollinators and flowers or fungi and plant roots. Unlike commensalism, where only one benefits, or parasitism and competition, where at least one is harmed, mutualism is a relationship that often leads to specialized co-evolved traits.

a food source to lure and more easily capture its unsuspecting prey.

96. (1) Mutualism
The interaction between insect-pollinated flowers and their pollinating agents is a classic example of mutualism. The flower benefits from the transfer of pollen, which is necessary for fertilization and reproduction. In exchange, the pollinator, such as a bee or butterfly, receives rewards like nectar and pollen, which serve as essential food sources. This relationship has led to the specialized co-evolution of traits.

97. (2) Gause's hypothesis
Gause's hypothesis, also known as the competitive exclusion principle, states that two species competing for identical resources cannot coexist indefinitely in the same niche. Eventually, the more efficient competitor will outcompete the other, leading to its local extinction or a shift in its niche. This principle explains why diverse species in a habitat usually have distinct ecological roles to minimize competition.

98. (1) biotic potential
Biotic potential refers to the maximum reproductive capacity of a population under optimal environmental conditions, such as unlimited food and the absence of predators or disease. It represents the innate ability of a species to increase its numbers without any external constraints. In reality, this potential is rarely achieved because various environmental resistances act to limit population growth and maintain stability.

99. (1) Nerium
Sunken stomata are a xerophytic adaptation found in plants like Nerium that live in arid or dry environments. These stomata are located deep within pits in the leaf surface, which creates a pocket of humid air. This significantly reduces the rate of transpiration by minimizing the exposure of stomatal openings to dry air, thereby helping the plant effectively conserve water.

100. (2) Tropical rainforests
Tropical rainforests have the highest density of organisms and biodiversity of any terrestrial biome. This is due to the consistently warm temperatures, high rainfall, and abundant sunlight, which support rapid plant growth and a multi-layered forest structure. These conditions provide a wide variety of niches and food sources, allowing a vast number of different plant and animal species to coexist together.

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101. (2) Fossorial
In desert grasslands, environmental conditions are often extreme, with high daytime temperatures and low water availability. Consequently, fossorial animals—those adapted for digging and living underground—are relatively more abundant. By residing in burrows, these animals can avoid the intense surface heat and conserve moisture, emerging only when conditions are more favorable. This lifestyle is a key adaptation for survival in biomes.

102. (4) thorn forests.
Plants such as Prosopis, Acacia, and Capparis are typical inhabitants of tropical thorn forests. These regions are characterized by low rainfall and high temperatures. To survive these arid conditions, these plants have evolved specialized adaptations such as small, thick leaves to reduce transpiration and sharp thorns for protection against herbivores. These forests are common in dry parts of the Indian subcontinent.

103. (2) Oceanic island communities
Oceanic island communities are particularly vulnerable to invasion by outside species. Because these ecosystems have evolved in isolation, they often have fewer species and lack the complex competitive relationships found on continents. When invasive plants or animals are introduced, they can easily outcompete native species that have no natural defenses, leading to significant disruptions in the unique ecological balance and biodiversity.

104. (4) pseudocopulation.
Pseudocopulation is a specialized pollination mechanism observed in certain orchids, such as Ophrys. The flower's petal mimics the appearance and scent of a female insect, like a wasp or bee. Male insects are attracted and attempt to mate with the flower, unintentionally picking up or depositing pollen in the process. This form of sexual deceit ensures effective pollination without any reward.

105. (2) seeds
Therophytes are annual plants that complete their entire life cycle within a single favorable season. During adverse periods, such as cold winters or

potential harm. Head lice are classic examples as they live on the human scalp, feed on blood, and complete their life cycle there. While female mosquitoes suck blood, they do not live on the host. Similarly, a fetus is not a biological parasite.

68. (2) $dN/dt = rN[(K-N)/K]$
Logistic population growth describes how a population grows when resources are finite. The equation models this process, where N is population size, r is the intrinsic rate of increase, and K is the carrying capacity. The term in parentheses represents the unused portion of the carrying capacity, which causes the growth rate to slow as the population density increases and eventually stabilizes.

69. (4) Regulator Conformer Partial regulator
Organisms respond differently to environmental changes. Regulators maintain a constant internal environment despite fluctuating external conditions. Conformers have internal conditions that change along with the environment. Partial regulators can maintain homeostasis over a certain range of environmental conditions but become conformers outside that range. This diagrammatic representation helps in understanding the diverse physiological strategies used by different species to survive.

70. (3) Predator is an organism that catches and kills other organism for food.
A predator is defined as an organism that hunts, catches, and kills another organism, known as the prey, to consume it for food. This interaction is beneficial for the predator and lethal for the prey. While other definitions describe specific interactions, the description of a predator as an organism that kills for nourishment is the most accurate and appropriately defined biological concept.

71. (3) hydrophytes.
Hydrophytes are plants that are partially or completely submerged in water. Because they are surrounded by an aquatic medium, they do not require extensive vascular tissue for water transport or mechanical tissue for structural support. Additionally, they lack a thick cuticle because water loss is not a concern. These anatomical reductions are specialized adaptations that allow these plants to thrive in water.

72. (4) "A" is more recent and shows slight reduction in the growth rate.
Comparing age-sex pyramids over time helps track population trends. If a more recent pyramid shows a narrower base compared to an earlier one, it indicates a decrease in the birth rate and a reduction in the proportion of young individuals. This shift suggests that measures taken to control population growth have been effective, leading to a slowing of the overall expansion.

73. (3) 3 and 4
The kangaroo rat in North American deserts has evolved remarkable adaptations for water conservation. It meets its water requirements through internal fat oxidation and does not need to drink. Furthermore, it excretes highly concentrated urine to minimize water loss. It also lacks sweat glands and uses behavioral strategies instead of water-intensive physiological processes to regulate its body temperature in the intense heat.

74. (3) temperate deciduous forests.
Quercus species, commonly known as oak trees, are a dominant and characteristic component of temperate deciduous forests. These trees are well-adapted to environments with moderate rainfall and distinct seasonal temperature changes. They typically shed their leaves during the autumn to conserve water and survive the cold winter months. These forests support a diverse array of flora and fauna in both hemispheres.

75. (1) population
The geometric representation of age structure, often shown as an age pyramid, is a fundamental characteristic used to describe a population. It illustrates the distribution of individuals across various age groups, such as pre-reproductive, reproductive, and post-reproductive. Analyzing this structure allows ecologists to predict the future growth, stability, or decline of a specific group of organisms of the same species.

76. (2) Its population growth curve is of J-type.
A J-shaped growth curve occurs when a population undergoes rapid, explosive expansion due to abundant resources and favorable conditions, such as the rainy season for certain insects. This exponential growth continues until a limiting factor is suddenly reached or the environment changes drastically, leading to a

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115. (4) support life.
Soil fertility is a measure of the soil's capacity to support plant growth and maintain a healthy ecosystem. While it involves the ability to retain nutrients, hold water, and contain organic matter, its ultimate indicator is how well it can sustain various forms of life. Fertile soil provides the necessary physical and chemical environment for roots to thrive and soil organisms to function.

116. (1) texture
The relative proportions of different-sized particles, such as sand, silt, and clay, determine the texture of the soil. Soil texture is a fundamental property that influences many other characteristics, including water-holding capacity, aeration, and nutrient retention. By understanding soil texture, farmers and ecologists can better manage land use, select appropriate crops, and predict how an ecosystem will respond to factors.

117. (2) tendency of biological systems to resist change
Homeostasis is the ability of a biological system or organism to maintain a stable internal environment despite fluctuations in external conditions. This process involves various self-regulatory mechanisms that resist change and keep physiological variables like temperature and pH within a narrow, optimal range. Maintaining homeostasis is essential for the survival and proper functioning of all living organisms in a changing world.

118. (3) clay and humus
Deep black soil is highly productive due to its high proportion of clay and organic matter, or humus. The clay particles provide excellent water-holding capacity and mineral content, while the humus enhances soil structure and provides essential nutrients for plant growth. This combination makes black soil particularly well-suited for growing crops like cotton and various cereals in many productive regions.

119. (2) tendency to resist change
Homeostasis refers to the innate tendency of living organisms and biological systems to maintain internal stability while adjusting to external changes. By employing various feedback mechanisms, the body can resist significant alterations in its internal state, such as core body temperature. This self-regulating property is a hallmark of life and is critical for ensuring that metabolic processes continue to operate efficiently.

120. (2) Symbiosis when the interaction is useful to both the populations.
In ecological terms, symbiosis refers to a close and long-term biological interaction between two different species. While the term can broadly include various types of relationships, it is most frequently used to describe mutualistic interactions that are useful and beneficial to both populations. This contrasts with commensalism, where only one party benefits, and other interactions where at least one is harmed.

121. (1) symbiosis
A lichen is a complex life form that arises from a symbiotic association between a fungus and an alga or cyanobacterium. In this mutualistic relationship, the alga produces food through photosynthesis, which it shares with the fungus. In return, the fungus provides structural support, protection, and absorbs minerals. This partnership allows lichens to survive in harsh environments where neither could live.

122. (1) mutualism/symbiosis
A mutually beneficial association that is essential for the survival of both partners is known as obligate mutualism or symbiosis. In these relationships, neither species can complete its life cycle or survive for long without the presence of the other. Examples include the relationship between certain insects and their intestinal bacteria or the complex bond between Yucca plants and their specific moths.

123. (2) closely related organisms growing in the same area/niche
Competition for essential resources like light, nutrients, and space is most intense between closely related organisms that occupy the same niche. Because their requirements are nearly identical, they are in direct competition for every available unit of resource. This scenario is the primary driver behind Gause's competitive exclusion principle, which often results in one species being outcompeted or excluded.

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CHAPTER 31
Ecosystem

2026 (RE-NEET)

1. Which of the following statements are correct?
(a) Energy flow from producers to consumers is unidirectional;
(b) Energy pyramid can never be inverted;
(c) Transfer of energy follows the 1% law.
(1) (a) and (c) only
(2) (b) and (c) only
(3) (a), (b) and (c)
(4) (a) and (b) only

2026 (RE-NEET)

2. Which of the following are primary consumers in a food chain?
(1) Herbivores (2) Carnivores
(3) Parasites (4) Predators

2026 (CANCELLED)

3. Match List I with List II:
List I:
A. Productivity
B. Net primary productivity
C. Gross primary productivity
D. Secondary productivity
List II:
I. Gross primary productivity minus respiration losses
II. Rate of formation of new organic matter by consumers
III. Rate of biomass production
IV. Rate of production of organic matter during photosynthesis
(1) A-III, B-I, C-IV, D-II
(2) A-I, B-III, C-IV, D-II
(3) A-I, B-III, C-IV, D-II
(4) A-III, B-I, C-II, D-IV

2026 (CANCELLED)

4. Match List I with List II:
List I:
A. Decomposition
B. Detritus
C. Mineralisation
D. Humification
List II:
I. Accumulation of dark coloured amorphous colloidal substance
II. Release of inorganic nutrients by the activity of microbes in soil
III. Breaking down of complex organic matter into inorganic substances
IV. Dead remains of plants and animals including fecal matter
(1) A-IV, B-III, C-I, D-II
(2) A-III, B-IV, C-II, D-I
(3) A-I, B-II, C-III, D-IV
(4) A-II, B-III, C-I, D-IV

2026 (CANCELLED)

5. Ecological pyramids represent the relationship between the organisms at different trophic levels and they are generally inverted for:
(1) Pyramid of number in grassland
(2) Pyramid of energy in pond ecosystem
(3) Pyramid of biomass in grassland
(4) Pyramid of biomass in sea

2025

6. Given below are two statements:
Statement I: The primary source of energy in an ecosystem is solar energy.
Statement II: The rate of production of organic matter during photosynthesis in an ecosystem is called net primary productivity (NPP).
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

2025

7. Which of the following is the unit of productivity of an ecosystem?
(1) KCal m^{-3}
(2) (KCal m^{-2})yr^{-1}
(3) gm^{-2}
(4) KCal m^{-2}

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2025

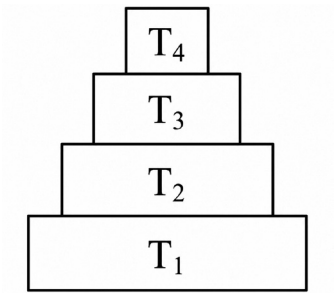
8. Given below are two statements:
Statement I: In ecosystem, there is unidirectional flow of energy of sun from producers to consumers.
Statement II : Ecosystems are exempted from 2nd law of thermodynamics.
In the light of the above statements, choose the most appropriate answer from the options given below:
(1) Statement I is correct but statement II is incorrect.
(2) Statement I is incorrect but statement II is correct.
(3) Both statement I and statement II are correct.
(4) Both statement I and statement II are incorrect.

2024

9. In an ecosystem if the net primary productivity (NPP) of first trophic level is $100x$ (kcal m^{-2}) yr^{-1}, what would be the GPP (Gross Primary Productivity) of the third trophic level of the same ecosystem?
(1) $x/10$ (kcal m^{-2}) yr^{-1}
(2) x (kcal m^{-2}) yr^{-1}
(3) $10x$ (kcal m^{-2}) yr^{-1}
(4) $100x/3x$ (kcal m^{-2}) yr^{-1}

RE-EXAM 2024

10. Consider the pyramid of energy of an ecosystem given below.



If T4 equivalent to 1000 J, what is the value at T1 ?
(1) 10000/10 J
(2) 10000/10 × 4 J
(3) 10,000 J
(4) 10,00,000 J

RE-EXAM 2024

11. Which one of the following is not a limitation of ecological pyramids?
(1) Saprophytes are not given any place in ecological pyramids.
(2) It assumes a simple food chain, that almost never exists in nature.
(3) It accommodates a food web.
(4) It does not take into account the same species belonging to two or more trophic levels.

2023

12. In the equation GPP – R = NPP
GPP is Gross Primary Productivity
NPP is Net Primary Productivity
R here is _____.
(1) respiratory loss
(2) reproductive allocation
(3) photosynthetically active radiation
(4) respiratory quotient

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2023

13. Identify the correct statements :
A. Detrivores perform fragmentation.
B. The humus is further degraded by some microbes during mineralisation.
C. Water soluble inorganic nutrients go down into the soil and get precipitated by a process called leaching.
D. The detritus food chain begins with living organisms.
E. Earthworms break down detritus into smaller particles by a process called catabolism.
Choose the correct answer from the options given below:
(1) C, D, E only
(2) D, E, A only
(3) A, B, C only
(4) B, C, D only

2022

14. Given below are two statements.
Statement I : Decomposition is a process in which the detritus is degraded into simpler substances by microbes.
Statement II : Decomposition is faster if the detritus is rich in lignin and chitin.
In the light of the above statements, choose the correct answer from the options given below :
(1) Both Statement I and Statement II are correct .
(2) Both Statement I and Statement II are incorrect.
(3) Statement I is correct but Statement II is incorrect.
(4) Statement I is incorrect but Statement II is correct.

2022

15. Detritivores breakdown detritus into smaller particles. This process is called:
(1) Catabolism
(2) Fragmentation
(3) Humification
(4) Decomposition

2021

16. In the equation, GPP – R = NPP
R represents
(1) respiration losses
(2) radiant energy
(3) retardation factor
(4) environment factor

2021

17. Which of the following statements is not correct?
(1) Pyramid of numbers in a grassland ecosystem is upright.
(2) Pyramid of biomass in sea is generally inverted.
(3) Pyramid of biomass in sea is generally upright.
(4) Pyramid of energy is always upright.

2020

18. In relation to Gross primary productivity and Net primary productivity of an ecosystem, which one of the following statements is correct?
(1) Gross primary productivity is always less than Net primary productivity.
(2) Gross primary productivity is always more than Net primary productivity.
(3) Gross primary productivity and Net primary productivity are one and same.
(4) There is no relationship between Gross primary productivity and Net primary productivity.

2020

19. Match the trophic levels with their correct species examples in grassland ecosystem.

	Column I		Column II
A.	Fourth trophic level	(i)	Crow
B.	Second trophic level	(ii)	Vulture
C.	First trophic level	(iii)	Rabbit
D.	Third trophic level	(iv)	Grass

Select the correct option.
(1) (A)-(ii); (B)-(iii); (C)-(iv); (D)-(i)
(2) (A)-(iii); (B)-(ii); (C)-(i); (D)-(iv)
(3) (A)-(iv); (B)-(iii); (C)-(ii); (D)-(i)
(4) (A)-(i); (B)-(ii); (C)-(iii); (D)-(iv)

2019

20. Which of the following ecological pyramids is generally inverted?
(1) Pyramid of biomass in a sea
(2) Pyramid of numbers in grassland
(3) Pyramid of energy
(4) Pyramid of biomass in a forest

2018

21. What type of ecological pyramid would be obtained with the following data?
Secondary consumer : 120 g
Primary consumer : 60 g
Primary producer : 10 g
(1) Inverted pyramid of biomass
(2) Pyramid of energy
(3) Upright pyramid of numbers
(4) Upright pyramid of biomass

2017

22. Which ecosystem has the maximum biomass?
(1) Grassland ecosystem
(2) Pond ecosystem
(3) Lake ecosystem
(4) Forest ecosystem

NEET-I 2016

23. The term ecosystem was coined by
(1) E. Haeckel (2) E.Warming
(3) E.P. Odum (4) A. G. Tansley.

NEET-I 2016

24. Which one of the following is a characteristic feature of cropland ecosystem?
(1) Absence of weeds
(2) Ecological succession
(3) Absence of soil organisms
(4) Least genetic diversity

NEET-II 2016

25. The primary producers of the deep-sea hydrothermal vent ecosystem are
(1) green algae
(2) chemosynthetic bacteria
(3) blue-green algae
(4) coral reefs.

2015 Cancelled

26. Vertical distribution of different species occupying different levels in a biotic community is known as
(1) zonation
(2) pyramid
(3) divergence
(4) stratification.

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2015 Cancelled

27. The mass of living material at a trophic level at a particular time is called
(1) net primary productivity
(2) standing crop
(3) gross primary productivity
(4) standing state.

2015 Cancelled

28. In an ecosystem the rate of production of organic matter during photosynthesis is termed as
(1) secondary productivity
(2) net productivity
(3) net primary productivity
(4) gross primary productivity.

2015

29. Most animals that live in deep oceanic waters are
(1) tertiary consumers
(2) detritivores
(3) primary consumers
(4) secondary consumers.

2014

30. If 20 J of energy is trapped at producer level, then how much energy will be available to peacock as food in the following chain?
Plant → Mice → Snake → Peacock
(1) 0.02 J (2) 0.002 J
(3) 0.2 J (4) 0.0002 J

2013

31. Secondary productivity is rate of formation of new organic matter by
(1) consumers (2) decomposers
(3) producers (4) parasites.

Mains 2013

32. The rate of formation of new organic matter by rabbit in a grassland, is called
(1) net productivity
(2) secondary productivity
(3) net primary productivity
(4) gross primary productivity.

2013

33. Which one of the following processes during decomposition is correctly described?
(1) Catabolism - Last step in the decomposition under fully anaerobic condition
(2) Leaching - Water soluble inorganic nutrients rise to the top layers of soil
(3) Fragmentation - Carried out by organisms such as earthworm
(4) Humification - Leads to the accumulation of a dark coloured substance humus which undergoes microbial action at a very fast rate.

Karnataka NEET 2013

34. Which of the following is a primary consumer in maize field ecosystem?
(1) Grasshopper
(2) Wolf
(3) Phytoplankton
(4) Lion

Karnataka NEET 2013

35. When man eats fish which feeds on zooplanktons which have eaten small plants, the producer in this chain is
(1) small plants (2) fish
(3) man (4) zooplankton.

2012

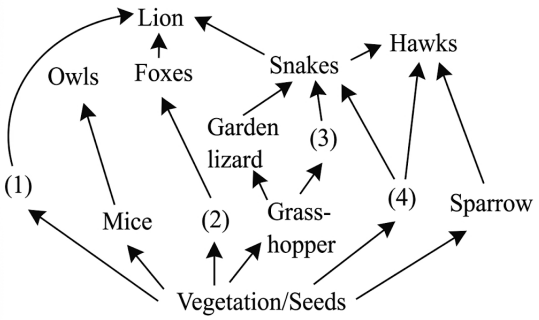
36. Which one of the following is not a functional unit of an ecosystem?
(1) Energy flow
(2) Decomposition
(3) Productivity
(4) Stratification

2012

37. Identify the possible link "A" in the following food chain.
Plant → Insect → Frog → "A" → Eagle
(1) Rabbit (2) Wolf
(3) Cobra (4) Parrot

Mains 2012

38. Identify the likely organisms (1), (2), (3) and (4) in the food web shown below.



(a) (1)-Deer; (2)-Dog; (3)-Rat; (4)-Squirrel
(b) (1)-Rabbit; (2)-Squirrel; (3)-Dog; (4)-Cat
(c) (1)-Frog; (2)-Bat; (3)-Tortoise; (4)-Rat
(d) (1)-Rat; (2)-Deer; (3)-Crow; (4)-Pigeon

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rather than a complex food web. Additionally, saprophytes and decomposers are often excluded from these models. Asserting that pyramids accommodate food webs is inaccurate, as they generally represent simplified energy pathways.

12. (1) respiratory loss
Gross primary productivity reflects the total rate at which solar energy is captured during photosynthesis. However, plants utilize a portion of this energy for their own metabolic processes and maintenance. This utilized portion is known as respiratory loss. Subtracting these respiratory losses from the gross productivity yields the net primary productivity which is available for the next trophic level.

13. (3) A, B, C only
Decomposition involves several distinct stages that break down organic matter. Detritivores like earthworms perform fragmentation by breaking detritus into smaller pieces. Mineralization occurs when microbes further degrade humus into inorganic nutrients. Leaching is the process where water-soluble inorganic nutrients sink into the soil profile. Together, these processes ensure the efficient recycling of nutrients within a healthy ecosystem.

14. (3) Statement I is correct but Statement II is incorrect.
Decomposition is a biological process where microbes break down complex organic detritus into simpler inorganic substances. The rate of this process is heavily influenced by the chemical composition of the detritus. Materials rich in nitrogen and sugars decompose rapidly. Conversely, high concentrations of lignin and chitin significantly slow down the decomposition process because these substances are difficult to breakdown.

15. (2) Fragmentation
The initial stage of decomposition involves the physical breakdown of detritus into much smaller particles. This specific process is referred to as fragmentation and is typically carried out by detritivores such as earthworms. By increasing the surface area of the organic matter, fragmentation facilitates subsequent chemical breakdown by microbes. This stage is crucial for the overall nutrient cycling process.

16. (1) respiration losses
In the context of ecosystem productivity, plants synthesize organic matter through photosynthesis, which is quantified as gross primary productivity. A significant portion of this energy is consumed by the plants themselves for cellular respiration. These respiration losses are represented by the variable R. The remaining biomass, termed net primary productivity, is what becomes available to the herbivore population.

17. (3) Pyramid of biomass in sea is generally upright.
Pyramid of biomass in sea is generally inverted. Ecological pyramids represent the relationship between different trophic levels in terms of energy, biomass, or numbers. In aquatic environments, the pyramid of biomass is typically inverted because the standing crop of consumers often exceeds that of the primary producers. This occurs because phytoplankton have high turnover rates. However, the pyramid of energy always remains upright in every ecosystem.

18. (2) Gross primary productivity is always more than Net primary productivity.
Gross primary productivity represents the total amount of solar energy fixed by producers through photosynthesis. Net primary productivity is the amount of biomass remaining after plants have used some energy for their own respiration. Therefore, gross primary productivity is always greater than net primary productivity because respiration always consumes a portion of the total energy fixed by the plant.

19. (1) (ii) (iii) (iv) (i)
In a grassland ecosystem, the first trophic level consists of producers like grass. The second level includes primary consumers such as rabbits that feed on the grass. Secondary consumers like crows occupy the third level by consuming primary consumers. Top predators or scavengers like vultures represent the fourth trophic level. This structure illustrates the hierarchical flow of energy.

20. (1) Pyramid of biomass in a sea
While most ecological pyramids are upright, certain exceptions exist depending on the ecosystem and the parameter measured. In marine ecosystems, the pyramid of biomass is frequently inverted. This happens because the total biomass of the small, rapidly reproducing

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2008

50. The slow rate of decomposition of fallen logs in nature is due to their
(1) anaerobic environment around them
(2) low cellulose content
(3) low moisture content
(4) poor nitrogen content.

2008

51. Consider the following statements concerning food chains.
A. Removal of 80% tigers from an area resulted in greatly increased growth of vegetation.
B. Removal of most of the carnivores resulted in an increased population of deers.
C. The length of food chains is generally limited to 3-4 trophic levels due to energy loss.
D. The length of food chains may vary from 2 to 8 trophic levels.
Which two of the above statements are correct?
(1) A, D (2) A, B
(3) B, C (4) C, D

2007

52. Which one of the following ecosystem types has the highest annual net primary productivity?
(1) Tropical deciduous forest
(2) Temperate evergreen forest
(3) Temperate deciduous forest
(4) Tropical rainforest

2006

53. Which one of the following is not used for construction of ecological pyramids?
(1) Fresh weight
(2) Dry weight
(3) Number of individuals
(4) Rate of energy flow

2004

54. Which of the following is expected to have the highest value ($gm/m^2/yr$) in a grassland ecosystem?
(1) Secondary production
(2) Tertiary production
(3) Gross production (GP)
(4) Net production (NP)

2002

55. Bamboo plant is growing in a fir forest then what will be the trophic level of it?
(1) First trophic level (T_1)
(2) Second trophic level (T_2)
(3) Third trophic level (T_3)
(4) Fourth trophic level (T_4)

2001

56. Plant decomposers are
(1) monera and fungi
(2) fungi and plants
(3) protista and animalia
(4) animalia and monera.

2000

57. Which is the reason for highest biomass in aquatic ecosystem?
(1) Nano plankton, blue green algae and green algae
(2) Sea grass and slime moulds
(3) Benthic and brown algae
(4) Diatoms

1999

58. Energy transfer from one trophic level to other, in a food chain, is
(1) 10%
(2) 20%
(3) 1%
(4) 2%.

1998

59. The rate at which light energy is converted into chemical energy of organic molecules is the ecosystem's
(1) net secondary productivity
(2) gross primary productivity
(3) net primary productivity
(4) gross secondary productivity.

1998

60. In a terrestrial ecosystem such as forest, maximum energy is in which trophic level?
(1) T_3
(2) T_4
(3) T_1
(4) T_2

1997

61. Which of the following ecosystem has the highest gross primary productivity?
(1) Mangroves
(2) Rainforest
(3) Grassland
(4) Coral reef

1997

62. Which of the following acts as "nature's scavengers"?
(1) Insects
(2) Microorganisms
(3) Man
(4) Animals

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mice receive two joules. The snakes consuming the mice then obtain zero point two joules. Finally, the peacock at the top of this chain receives only zero point zero two joules.

31. (1) consumers
Secondary productivity refers to the rate at which consumers build up their own biomass by utilizing the organic matter they have ingested. Unlike primary producers that fix energy from sunlight, consumers derive energy by eating other organisms. This newly formed biomass represents the energy available to the next consumer level in the food chain or food web of an ecosystem.

32. (2) secondary productivity
When a herbivore like a rabbit consumes grass, it converts a portion of that plant matter into its own body tissues. The rate at which this new organic matter is synthesized by the consumer is specifically called secondary productivity. This process accounts for the energy stored by heterotrophs after accounting for their metabolic needs and waste products during digestion.

33. (3) Fragmentation - Carried out by organisms such as earthworm
Decomposition is a complex process involving multiple steps to recycle nutrients. Fragmentation occurs when detritivores, such as earthworms, physically break down detritus into smaller particles. This stage is followed by leaching, where water-soluble nutrients move deeper into the soil. Catabolism involves the chemical breakdown of organic matter by microbes, while humification creates stable, dark-coloured humus for the environment.

34. (1) Grasshopper
In a maize field ecosystem, the maize plants act as the primary producers by capturing solar energy. Organisms that feed directly on these producers are classified as primary consumers. Grasshoppers are classic examples of primary consumers in this habitat as they eat the leaves of the maize plants. In contrast, lions and wolves are higher-level predators.

35. (1) small plants
Every food chain begins with a producer that can synthesize organic molecules from inorganic sources. In the described chain, small aquatic plants or algae capture sunlight to create chemical energy. These plants serve as the foundation for the entire sequence. Zooplankton eat the plants, fish eat the zooplankton, and humans consume the fish, but energy originates from plants.

36. (4) Stratification
Ecosystems are characterized by specific functional units that drive their internal processes. These include productivity, which is the rate of biomass production, and decomposition, which involves nutrient recycling. Energy flow describes the movement of energy through trophic levels. While stratification describes the physical vertical layering of an ecosystem, it is considered a structural component rather than a functional unit.

37. (3) Cobra
In this specific food chain, the sequence follows the transfer of energy from one organism to another. Plants are eaten by insects, which are then consumed by frogs. The next logical link must be a predator that eats frogs and is itself eaten by an eagle. A cobra fits this role perfectly as a secondary or tertiary consumer.

38. (d) (1)-Rat; (2)-Deer; (3)-Crow; (4)-Pigeon
A food web consists of interconnected food chains showing various feeding relationships. In the provided diagram, different animals occupy specific niches based on what they consume and what preys upon them. Squirrels, cats, rats, and pigeons are common organisms that fill these roles in terrestrial environments. Correctly identifying them requires matching their typical diet and predators within the network.

39. (1) Level PC is "insects" and level SC is "small insectivorous birds".
Pyramids of numbers represent the population size at each trophic level. In many terrestrial systems, a single large producer can support numerous primary consumers, such as a tree hosting many insects. These insects are then consumed by a smaller number of secondary consumers, like insectivorous birds. This results in a specific shape where the middle level has many individuals.

40. (2) forest
The shape of the pyramid of numbers depends on the size and population of the organisms involved. In a forest, a single large tree can support a vast number of herbivorous insects,

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ANSWERS

1. (4) (a) and (b) only
Energy flow is unidirectional, from producers to consumers (a), and the pyramid of energy is always upright, never inverted (b). The transfer of energy follows the 10% law, not the 1% law (c wrong).

2. (1) Herbivores
Primary consumers feed directly on producers (green plants). Herbivores eat plants and therefore occupy the position of primary consumers. Carnivores and predators feed on other animals as secondary or tertiary consumers.

3. (1) A-III, B-I, C-IV, D-II
Productivity is the rate of biomass production. Net primary productivity equals gross primary productivity minus respiratory losses. Gross primary productivity is the rate of organic matter production during photosynthesis. Secondary productivity is the rate of formation of new organic matter by consumers (heterotrophs).

4. (2) A-III, B-IV, C-II, D-I
Decomposition is breaking complex organic matter into inorganic substances. Detritus is dead remains of plants and animals including faecal matter. Mineralisation is the release of inorganic nutrients by soil microbes. Humification is the accumulation of dark, amorphous colloidal humus. This gives A-III, B-IV, C-II, D-I.

5. (4) Pyramid of biomass in sea
In an aquatic (sea) ecosystem, the biomass of phytoplankton (producers) is much less than that of the zooplankton and fishes that feed on them at a given time. This makes the pyramid of biomass inverted. The pyramid of energy is always upright and never inverted.

6. (1) Statement I is correct but statement II is incorrect.
Solar energy acts as the fundamental source of energy for almost all ecosystems on Earth. It is captured by autotrophs to initiate the flow of energy through various trophic levels. Gross primary productivity represents the total organic matter produced during photosynthesis. Net primary productivity is actually the remaining energy after accounting for respiratory losses by plants.

7. (2) (KCal m^{-2})yr^{-1}
Productivity in an ecosystem is defined as the rate of biomass production over a specific period. It is expressed in terms of energy per unit area per unit time to allow for accurate comparisons between different ecosystems. Standard units include weight measurements or kilocalories per square meter per year. This captures the efficiency of energy conversion and accumulation.

8. (1) Statement I is correct but statement II is incorrect.
Energy flow within an ecosystem follows a unidirectional path, moving from producers to various consumers without reversing. This process adheres strictly to the laws of thermodynamics. The second law states that energy transfer involves a loss of energy as heat, increasing entropy. Ecosystems require a constant supply of energy from the sun to counteract this natural energy dissipation.

9. (2) x (kcal m^{-2}) yr^{-1}
According to the ten percent law of energy transfer, only a small fraction of the energy at one level is available to the next. If the net primary productivity at the first trophic level is one hundred x, the second level receives ten x. Consequently, the third trophic level receives only x units of energy as gross productivity.

10. (4) 10,00,000 J
Energy pyramids illustrate the progressive decrease in available energy as it moves through successive trophic levels. Applying the ten percent rule in reverse, if the fourth level contains one thousand joules, the third level must have ten thousand. The second level then possesses one hundred thousand joules, and the first level at the base contains one million joules.

11. (3) It accommodates a food web.
Ecological pyramids have specific limitations, such as failing to account for species that occupy multiple trophic levels simultaneously. They typically assume a simple, linear food chain

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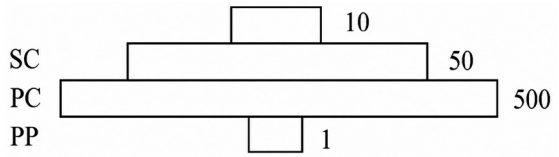
2012

39. Given below is an imaginary pyramid of numbers. What could be one of the possibilities about certain organisms at some of the different levels?



(1) Level PC is "insects" and level SC is "small insectivorous birds".
(2) Level PP is "phytoplanktons" in sea and "whale" on top level TC.
(3) Level one PP is "pipal trees" and the level SC is "sheep".
(4) Level PC is "rats" and level SC is "cats".

2012

40. The upright pyramid of number is absent in
(1) pond (2) forest
(3) lake (4) grassland.

2011

41. Mass of living matter at a trophic level in an area at any time is called
(1) standing crop
(2) detritus
(3) humus
(4) standing state.

Mains 2011

42. The breakdown of detritus into smaller particles by earthworm is a process called
(1) humification
(2) fragmentation
(3) mineralisation
(4) catabolism.

2011

43. Of the total incident solar radiation the proportion of PAR is
(1) about 70%
(2) about 60%
(3) less than 50%
(4) more than 80%.

Mains 2011

44. Which one of the following animals may occupy more than one trophic levels in the same ecosystem at the same time?
(1) Sparrow
(2) Lion
(3) Goat
(4) Frog

2011

45. Which one of the following statements for the pyramid of energy is incorrect ?
(1) Its base is broad.
(2) It shows energy content of different trophic level organisms.
(3) It is inverted in shape.
(4) It is upright in shape.

2010

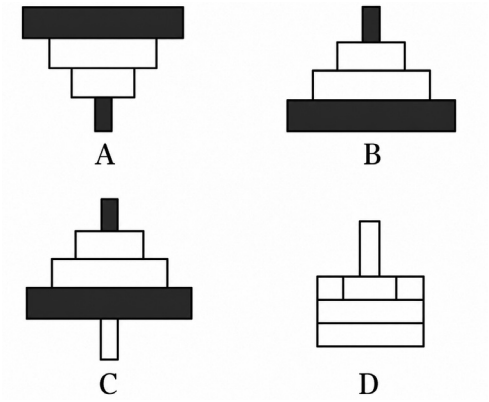
46. Which one of the following is one of the characteristics of a biological community?
(1) Stratification
(2) Natality
(3) Mortality
(4) Sex-ratio

2010

47. The biomass available for consumption by the herbivores and the decomposers is called
(1) net primary productivity
(2) secondary productivity
(3) standing crop
(4) gross primary productivity.

Mains 2010

48. Which of the following representations shows the pyramid of numbers in a forest ecosystem?



(1) D
(2) A
(3) B
(4) C

2009

49. Which one of the following types of organisms occupy more than one trophic level in a pond ecosystem?
(1) Fish
(2) Zooplankton
(3) Frog
(4) Phytoplankton

NODIA

phytoplankton is lower at any given moment than the biomass of the larger, longer-lived zooplankton and fish that consume them.

21. (1) Inverted pyramid of biomass
The provided data indicates that the biomass increases at each successive trophic level, from ten grams at the producer level to one hundred and twenty grams at the secondary consumer level. When the biomass of consumers significantly exceeds that of the producers, the resulting graphical representation is an inverted pyramid. This pattern is characteristic of certain aquatic ecosystem habitats.

22. (4) Forest ecosystem
Different ecosystems support varying levels of total living organic matter, known as biomass. Forest ecosystems generally exhibit the highest biomass because they contain large, long-lived woody plants like trees. These organisms accumulate massive amounts of carbon over time compared to the smaller plants found in grasslands or the transient, microscopic primary producers typically found in most aquatic ecosystems.

23. (4) A. G. Tansley.
The concept of an ecosystem was formally introduced into the field of ecology by the British botanist A.G. Tansley in 1935. He defined it as a functional unit comprising both the biotic community and its physical environment, interacting together. This term emphasizes the complex relationships and energy exchanges between living organisms and their non-living surroundings.

24. (4) Least genetic diversity
Croplands are artificial or man-made ecosystems managed specifically for agricultural production. Because they are typically dominated by a single species or a few varieties of crops, they possess significantly lower genetic diversity compared to natural ecosystems. These systems require regular human intervention, such as irrigation and pest control, and do not follow the natural process of ecological succession.

25. (2) chemosynthetic bacteria
In the extreme conditions of deep-sea hydrothermal vents where sunlight cannot reach, photosynthesis is impossible. Instead, primary production is driven by chemosynthetic bacteria. These unique organisms derive energy from the oxidation of inorganic chemicals, such as hydrogen sulfide, flowing from the vents. They form the foundation of the food web, supporting diverse communities of specialized deep-sea animal species.

26. (4) stratification.
Biological communities often exhibit a layered structure where different species occupy distinct vertical levels. This vertical distribution is known as stratification. For example, in a forest ecosystem, trees form the top canopy layer, followed by shrubs in the middle, and herbs or grasses at the bottom level. Stratification allows diverse species to coexist by utilizing different niches.

27. (2) standing crop
The total mass of living organisms present at a specific trophic level at any given time is referred to as the standing crop. This value is usually expressed in terms of fresh weight or dry weight per unit area. Measuring the standing crop helps ecologists understand the distribution of biomass and energy within the different levels of a particular ecosystem.

28. (4) gross primary productivity.
The total amount of solar energy captured and converted into organic matter by producers during photosynthesis per unit area and time is called gross primary productivity. This represents the total photosynthetic output before any metabolic consumption. It is a fundamental measure of the energy entering the biotic component of an ecosystem and determines the total energy available for life.

29. (2) detritivores
In the deep, dark layers of the ocean where sunlight is absent, primary production through photosynthesis cannot occur. Consequently, many organisms inhabiting these regions rely on the organic debris falling from the upper layers. These animals are primarily detritivores, which consume decaying organic matter and waste, playing a vital role in deep-sea nutrient cycling and energy flow pathways.

30. (1) 0.02 J
Following the ten percent energy transfer rule, only a small portion of energy moves up each level of a food chain. If plants have twenty joules,

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1996

63. The 10% energy transfer law of food chain was given by
(1) Lindemann
(2) Tansley
(3) Stanley
(4) Weismann.

1995

64. Which of the following is the most stable ecosystem?
(1) Mountain
(2) Ocean
(3) Forest
(4) Desert

1995

65. If we completely remove the decomposers from an ecosystem, its functioning will be adversely affected, because
(1) mineral movement will be blocked
(2) the rate of decomposition will be very high
(3) energy flow will be blocked
(4) herbivores will not receive solar energy.

1995

66. In a biotic community, the primary consumers are
(1) detritivores
(2) herbivores
(3) carnivores
(4) omnivores.

1994

67. The dominant second trophic level, in a lake ecosystem, is
(1) phytoplankton
(2) zooplankton
(3) benthos
(4) plankton.

1993

68. Maximum solar energy is trapped by
(1) planting trees
(2) cultivating crops
(3) growing algae in tanks
(4) growing grasses.

1993

69. Pyramid of numbers deals with number of
(1) species in an area
(2) individuals in a community
(3) individuals in a trophic level
(4) subspecies in a community.

1993

70. Pyramid of numbers in a pond ecosystem is
(1) irregular
(2) inverted
(3) upright
(4) spindle shaped.

1991

71. Food chain in which microorganisms breakdown the food formed by primary producers is
(1) parasitic food chain
(2) detritus food chain
(3) consumer food chain
(4) predator food chain.

1991

72. Pick up the correct food chain.
(1) Grass → Chameleon → Insect → Bird
(2) Grass → Fox → Rabbit → Bird
(3) Phytoplankton → Zooplankton → Fish
(4) Fallen leaves → Bacteria → Insect larvae

NODIA

1989

73. A very efficient converter of solar energy with net productivity of 204 kg/m^2 or more is the crop
(1) wheat
(2) sugarcane
(3) rice
(4) bajra.

1988

74. Upper part of sea/aquatic ecosystem contains
(1) plankton
(2) nekton
(3) plankton and nekton
(4) benthos.

1988

75. What is true of ecosystem?
(1) Primary consumers are least dependent upon producers.
(2) Primary consumers out-number producers.
(3) Producers are more than primary consumers.
(4) Secondary consumers are the largest and most powerful.

1988

76. In an ecosystem, which one shows one-way passage?
(1) Free energy
(2) Carbon
(3) Nitrogen
(4) Potassium

which are then eaten by fewer birds. This creates a spindle-shaped or partially inverted pyramid rather than a traditional upright one. In contrast, grasslands and ponds show upright pyramids.

41. (1) standing crop
The standing crop represents the total biomass of living organisms present at a particular trophic level in a given area at a specific time. It is a snapshot of the organic matter available within that level. This measurement is distinct from the standing state, which refers to the total amount of inorganic nutrients present in the soil or ecosystem.

42. (2) fragmentation
Fragmentation is the initial step of decomposition where detritus is physically broken down into smaller pieces. Earthworms are major contributors to this process in the soil. By ingesting and grinding organic matter, they increase the surface area available for microbial action. This mechanical breakdown is essential for the subsequent stages of leaching, catabolism, humification, and mineralization.

43. (3) less than 50%
Photosynthetically Active Radiation, or PAR, refers to the specific wavelengths of solar radiation that plants can use for photosynthesis. Out of the total incident solar radiation reaching the Earth, less than fifty percent falls within this usable range. Furthermore, plants only capture a small fraction of this PAR to produce organic matter, highlighting the limits of energy entry.

44. (1) Sparrow
Some organisms can occupy different trophic levels depending on their specific diet at a given moment. For example, a sparrow acts as a primary consumer when it eats seeds or fruits directly from plants. However, the same sparrow becomes a secondary consumer when it feeds on insects or worms. This flexibility is a common feature in complex natural food webs.

45. (3) It is inverted in shape.
The pyramid of energy illustrates the total amount of energy available at each trophic level. Due to the second law of thermodynamics, energy is lost as heat during every transfer. Consequently, the amount of energy always decreases as one moves to higher levels. This ensures that the pyramid of energy is always upright and can never be inverted.

46. (1) Stratification
A biological community is defined by its species composition and structural organization. Stratification is a key structural characteristic where different species are distributed into vertical layers. This organization reduces competition and allows for the coexistence of diverse organisms. In contrast, terms like natality, mortality, and sex-ratio are population attributes rather than characteristics used to describe an entire biological community.

47. (1) net primary productivity
Net primary productivity is the actual amount of organic matter that remains after plants have met their own metabolic needs through respiration. It represents the chemical energy stored in plant tissues that is available for herbivores and decomposers to consume. This value is critical because it sets the upper limit for the energy available to support all heterotrophic life.

48. (4) C
In a forest ecosystem, the pyramid of numbers often takes a non-traditional shape. A few very large producers, like trees, provide resources for a huge population of primary consumers, such as insects. These insects are then eaten by a smaller number of secondary consumers, such as birds. This distribution results in a spindle-shaped pyramid where the base is narrow.

49. (1) Fish
In a pond ecosystem, fish often occupy multiple trophic levels depending on their species and life stage. Some fish are primary consumers that eat phytoplankton or aquatic plants. Others are secondary consumers that prey on zooplankton, while larger predatory fish may act as tertiary consumers by eating smaller fish. This dietary diversity allows them to function at various levels.

50. (4) poor nitrogen content.
The rate at which fallen logs decompose in nature is influenced by their chemical makeup. Wood typically contains high levels of complex polymers like lignin and cellulose but is very low in nitrogen. Since microbes require nitrogen to build proteins and grow, this nutrient scarcity significantly limits their activity. Consequently,

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the decomposition of large woody debris is a slow process.

51. (3) B, C
Removing top carnivores from an ecosystem typically leads to an explosion in the population of their prey, such as deer, which can subsequently overgraze vegetation. Furthermore, the length of food chains is naturally limited to three or four levels. This limitation occurs because significant energy is lost as heat at each transfer, eventually leaving insufficient energy for higher levels.

52. (4) Tropical rainforest
Tropical rainforests are characterized by consistently warm temperatures and abundant rainfall throughout the year. These ideal conditions support continuous plant growth and high rates of photosynthesis. As a result, tropical rainforests exhibit the highest annual net primary productivity of any terrestrial ecosystem. They produce a massive amount of new biomass annually, supporting an incredibly diverse array of animal life.

53. (1) Fresh weight
Ecological pyramids are constructed to represent the relationships between trophic levels using quantitative data. Scientists typically use the number of individuals, the dry weight of biomass, or the rate of energy flow. Fresh weight is generally avoided because it varies significantly based on the water content of organisms, which does not accurately reflect the actual organic matter or energy.

54. (3) Gross production (GP)
Gross production represents the total amount of energy fixed by producers through photosynthesis before any losses occur. Because net production is calculated by subtracting respiratory losses from gross production, and secondary or tertiary production only involves a fraction of that energy, gross production will always have the highest numerical value in any ecosystem productivity measurement. It defines the total budget.

55. (1) First trophic level (T_1)
Regardless of the environment in which it grows, a bamboo plant is a green autotroph that produces its own food through photosynthesis. In the structure of an ecosystem, all such producers occupy the first trophic level. They form the foundation of the food chain by converting solar energy into chemical energy, which is then passed on to herbivores.

56. (1) monera and fungi
Decomposers are essential organisms that break down dead organic matter and recycle nutrients back into the ecosystem. The primary groups responsible for the decomposition of plant material are bacteria, which belong to the kingdom Monera, and various types of fungi. These organisms secrete enzymes to digest complex plant tissues like cellulose, playing a vital role in maintaining soil fertility.

57. (3) Benthic and brown algae
In certain aquatic ecosystems, the highest biomass is often found in large, multicellular algae such as brown algae and various benthic organisms. Unlike the microscopic phytoplankton that have a very high turnover rate but low standing biomass, these larger seaweeds can accumulate significant amounts of living tissue. They provide structure and a massive energy base for the coastal community.

NODIA

58. (1) 10%
The efficiency of energy transfer between trophic levels is remarkably low in natural ecosystems. On average, only about ten percent of the energy stored in the organic matter of one level is converted into the biomass of the next level. The remaining ninety percent is lost through metabolic processes, respiration as heat, and incomplete digestion or unconsumed organic material.

59. (2) gross primary productivity
Gross primary productivity is the fundamental rate at which producers in an ecosystem capture solar energy and transform it into the chemical energy of organic molecules during photosynthesis. This process represents the total intake of energy into the living system. Measuring this rate provides insight into the overall capacity of an ecosystem to support life and biomass.

60. (3) T_1
In any stable ecosystem, including a forest, the greatest amount of energy is always concentrated at the first trophic level, which consists of the primary producers. As energy moves through consumers at the second, third, and fourth levels, a large portion is lost at each step. Therefore,

the base of the energy pyramid always contains the most energy.

61. (4) Coral reef
Coral reefs are among the most productive ecosystems on the planet. They benefit from shallow, clear waters that allow for maximum light penetration and efficient nutrient cycling between the coral polyps and their symbiotic algae. These factors enable exceptionally high rates of photosynthesis, resulting in a gross primary productivity that often exceeds that of rainforests and other terrestrial systems.

62. (2) Microorganisms
Microorganisms such as bacteria and fungi are often described as nature's scavengers or decomposers. They perform the critical task of breaking down the remains of dead plants and animals. By decomposing complex organic waste into simple inorganic nutrients, they clean up the environment and ensure that essential elements like carbon and nitrogen are returned to the soil.

63. (1) Lindemann
The ten percent law of energy transfer, which states that only about ten percent of energy is passed from one trophic level to the next, was formulated by Raymond Lindeman in 1942. His work was foundational in the field of trophic ecology, providing a quantitative framework for understanding how energy limits the number of levels and the biomass supported.

64. (2) Ocean
Oceans are considered the most stable ecosystems on Earth due to several factors. Their massive size and high heat capacity buffer them against rapid temperature changes. Additionally, the chemical composition and salinity of seawater remain relatively constant over long periods. This environmental consistency provides a predictable habitat for a vast array of marine life, making oceanic systems highly resilient.

65. (1) mineral movement will be blocked
Decomposers play an indispensable role in ecosystems by breaking down dead organic matter into its inorganic components. If they were completely removed, the cycling of essential minerals and nutrients would stop. Organic waste would accumulate indefinitely, and the soil would eventually become depleted of the nutrients that plants need to grow. This would lead to ecosystem collapse.

NODIA

66. (2) herbivores
In the structure of a biotic community, primary consumers are those organisms that obtain their energy by feeding directly on primary producers like plants and algae. These organisms are known as herbivores. They serve as the vital link between the energy-capturing producers and the predatory carnivores at higher trophic levels, facilitating the flow of energy and nutrients.

67. (2) zooplankton
In a lake ecosystem, the first trophic level is occupied by microscopic producers known as phytoplankton. The second trophic level consists of the primary consumers that feed on these phytoplankton. In most aquatic environments, this role is filled by zooplankton, which are small animals or larvae that drift in the water and form the base for higher-level consumers.

68. (3) growing algae in tanks
Algae are highly efficient at capturing solar energy and converting it into biomass. When grown in controlled environments like tanks, they can achieve much higher photosynthetic efficiency compared to land plants or traditional crops. This is because factors like light intensity and nutrient availability can be optimized, and algae lack the non-photosynthetic structural tissues found in trees.

69. (3) individuals in a trophic level
An ecological pyramid of numbers is a graphical representation designed to show the total population of individual organisms at each successive trophic level within an ecosystem. It provides a visual count of the producers, primary consumers, secondary consumers, and so on. This helps ecologists understand the population dynamics and the capacity of producers to support higher levels.

70. (3) upright
In a typical pond ecosystem, a very large number of microscopic phytoplankton support a smaller number of zooplankton. These are then consumed by even fewer small fish, which are eventually eaten by a few large predatory fish. This steady decrease in the number of individuals at each higher level results in a classic upright pyramid shape for the population size.

2013, 2012

51. Which of the following represent maximum number of species among global biodiversity?
(1) Fungi
(2) Mosses and Ferns
(3) Algae
(4) Lichens

Karnataka NEET 2013, 2011

52. Which of the following has maximum genetic diversity in India?
(1) Mango
(2) Wheat
(3) Groundnut
(4) Rice

Karnataka NEET 2013

53. Which organization publishes the 'Red Data Book'?
(1) IUCN
(2) UNEP
(3) WWF
(4) GEF

2013

54. Which one of the following is not used for ex-situ plant conservation?
(1) Shifting cultivation
(2) Botanical gardens
(3) Field gene banks
(4) Seed banks

Karnataka NEET 2013

55. The largest tiger reserve in India is
(1) Valmiki
(2) Nagarjunasagar-Srisailam
(3) Periyar
(4) Nagarhole.

2012

56. Which one of the following areas in India, is a hotspot of biodiversity?
(1) Eastern Ghats
(2) Gangetic Plain
(3) Sunderbans
(4) Western Ghats

Mains 2012

57. Select the correct statement about biodiversity.
(1) The desert areas of Rajasthan and Gujarat have a very high level of desert animal species as well as numerous rare animals.
(2) Large scale planting of Bt cotton has no adverse effect on biodiversity.
(3) Western ghats have a very high degree of species richness and endemism.
(4) Conservation of biodiversity is just a fad pursued by the developed countries.

2011

58. Which one of the following have the highest number of species in nature?
(1) Fungi
(2) Insects
(3) Birds
(4) Angiosperms

Mains 2011

59. Biodiversity of a geographical region represents
(1) endangered species found in the region
(2) the diversity in the organisms living in the region
(3) genetic diversity in the dominant species of the region
(4) species endemic to the region.

Mains 2011

60. Sacred groves are specially useful in
(1) generating environmental awareness
(2) preventing soil erosion
(3) year-round flow of water in rivers
(4) conserving rare and threatened species.

Mains 2011

61. Consider the following statements (A - D) each with one or two blanks.
(A) Bears go into _(1)_ during winter to _(2)_ cold weather.
(B) A conical age pyramid with a broad base represents _(3)_ human population.
(C) A wasp pollinating a fig flower is an example of _(4)_ .
(D) An area with high levels of species richness is known as _(5)_ .
Which one of the following options, gives the correct fill ups for the respective blank numbers from (1) to (5) in the statements ?
(1) (3) - stable (4) - commensalism, (5)-marsh
(2) (1) - aestivation, (2) - escape, (3) - stable, (4) - mutualism
(3) (3) - expanding, (4) - commensalism, (5) - biodiversity park
(4) (1) - hibernation, (2) - escape, (3) - expanding (5) - hotspot

2010

62. Study the four statements (i-iv) given below and select the two correct ones out of them.
(i) A lion eating a deer and a sparrow feeding on grains are ecologically similar in being consumers.

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CHAPTER 32

Biodiversity and Conservation

NODIA

2026 (RE-NEET)

1. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A: Abingdon tortoise in Galapagos became extinct within a decade after goats were introduced.

Reason R: Goats were more efficient at browsing than Abingdon tortoise.

(1) A is correct but R is not correct
(2) A is not correct but R is correct
(3) Both A and R are correct and R is the correct explanation of A
(4) Both A and R are correct but R is not the correct explanation of A

2026 (RE-NEET)

2. Arrange in descending order of number of species in the Amazonian rain forest:

(a) Plants,
(b) Birds,
(c) Fishes,
(d) Invertebrates,
(e) Mammals.

Choose the correct answer from the options given below :

(1) (e) > (b) > (a) > (c) > (d)
(2) (b) > (a) > (d) > (c) > (e)
(3) (c) > (b) > (d) > (e) > (a)
(4) (d) > (a) > (c) > (b) > (e)

2026 (CANCELLED)

3. Exploring molecular, genetic and species-level diversity for products of economic importance is called:

(1) Biofortification
(2) Bioremediation
(3) Bioprospecting
(4) Biomagnification

2026 (CANCELLED)

4. Since the origin of life on Earth, there have been five episodes of mass extinction. How is the sixth extinction, in progress, different from the previous episodes?

(1) The present net species extinction rate is zero.
(2) The current species extinction rate is nearly 10 times faster than that in previous episodes.
(3) The present species extinction rates are 100 to 1000 times faster than in the pre-human times.
(4) The current species extinction rates are far lower than those in previous episodes.

2026 (CANCELLED)

5. Which of the following statements are correct?

A. The Amazon rainforest being cut and cleared for cultivation of soyabeans is an example of habitat loss.
B. Steller's sea cow and passenger pigeon became extinct due to over-exploitation by humans.
C. The Nile perch introduced into Lake Victoria in East Africa helped in population growth of cichlid fish in the lake.
D. Water hyacinth is an invasive species.
E. When a species becomes extinct, the plant and animal species associated with it are not affected.

(1) A, B and E only
(2) A, B and D only
(3) C, D and E only
(4) B, C and D only

2026 (CANCELLED)

6. Which of the following is an IN SITU conservation method?

(1) Sacred Groves
(2) Wildlife Safari Parks
(3) Botanical Gardens
(4) Seed Banks

2026 (CANCELLED)

7. "The Evil Quartet" of biodiversity loss includes which of the following?

(1) Over-exploitation; Alien species invasions; Air pollution; Co-extinctions
(2) Habitat loss and fragmentation; Air pollution; Water pollution; Co-extinctions
(3) Habitat loss and fragmentation; Over-exploitation; Alien species invasions; Co-extinctions

(4) Over-exploitation; Alien species invasions; Soil pollution; Co-extinctions

2025

8. Which one of the following is an example of ex-situ conservation?
(1) Zoos and botanical gardens
(2) Protected areas
(3) National Park
(4) Wildlife Sanctuary

2025

9. Match List I with List II.

	List-I		List-II
A.	The Evil Quartet	I.	Cryopreservation
B.	Ex situ conservation	II.	Alien species invasion
C.	Lantana camara	III.	Causes of biodiversity losses
D.	Dodo	IV.	Extinction

Choose the option with all correct matches.
(1) A-III, B-IV, C-II, D-I
(2) A-III, B-II, C-IV, D-I
(3) A-III, B-II, C-I, D-IV
(4) A-III, B-I, C-II, D-IV

2024

10. These are regarded as major causes of biodiversity loss:
A. Over exploitation
B. Co-extinction
C. Mutation
D. Habitat loss and fragmentation
E. Migration
Choose the correct option.
(1) A, C and D only
(2) A, B, C and D only
(3) A, B and E only
(4) A, B and D only

2024

11. List of endangered species was released by
(1) GEAC
(2) WWF
(3) FOAM
(4) IUCN.

2024

12. Tropical regions show greatest level of species richness because
A. tropical latitudes have remained relatively undistrubed for millions of years, hence more time was available for species diversification.
B. tropical environments are more seasonal.
C. more solar energy is available in tropics.
D. constant environments promote niche specialisation.
E. tropical environments are constant and predictable.
Choose the correct answer from the options given below.
(1) A, C, D and E only
(2) A and B only
(3) A, B and E only
(4) A, B and D only

2024

13. Match List I with List II.

	List-I		List-II
A.	Robert May	I.	Species-area relationship
B.	Alexander von Humboldt	II.	Long term ecosystem experiment using outdoor plots
C.	Paul Ehrlich	III.	Global species diversity at about 7 million
D.	David Tilman	IV.	Rivet popper hypothesis

Choose the correct answer from the options given below.
(1) A-II, B-III, C-I, D-IV
(2) A-III, B-I, C-IV, D-II
(3) A-I, B-III, C-II, D-IV
(4) A-III, B-IV, C-II, D-I

RE-EXAM 2024

14. The regions with high level of species richness, high degree of endemism and a loss of 70% of the species and habitat are identified as
(1) natural reserves
(2) sacred groves
(3) biodiversity hotspots
(4) biogeographical regions.

RE-EXAM 2024

15. Which one of the following is not included under in-situ conservation?
(1) Wildlife sanctuary
(2) Botanical garden
(3) Biosphere reserve
(4) National park

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RE-EXAM 2024

16. Cryopreservation technique is used for
(1) protection of environment
(2) protection of biodiversity hotspots
(3) preservation of gametes in viable and fertile condition for a long period
(4) in-situ conservation.

RE-EXAM 2024

17. Match List-I with List-II.

	List-I		List-II
A.	Biodiversity hotspot	I.	Khasi and Jaintia hills in Meghalaya
B.	Sacred groves	II.	World Summit on Sustainable Development 2002
C.	Johannesburg, South Africa	III.	Parthenium
D.	Alien species invasion	IV.	Western Ghats

Choose the correct answer from the options given below.
(1) A-IV, B-I, C-II, D-III
(2) A-II, B-III, C-IV, D-I
(3) A-I, B-IV, C-III, D-II
(4) A-III, B-I, C-II, D-IV

2024

18. The type of conservation in which the threatened species are taken out from their natural habitat and placed in special setting where they can be protected and given special care is called
(1) in-situ conservation
(2) biodiversity conservation
(3) semi-conservative method
(4) sustainable development.

Manipur NEET 2023

19. In 'Rivet Popper hypothesis', Paul Ehrlich compared the rivets in an airplane to
(1) species within a genus
(2) genetic diversity
(3) ecosystem
(4) genera within a family.

Manipur NEET 2023

20. The species of plants that plays a vital role in controlling the relative abundance of other species in a community is called _____.
(1) alien species
(2) endemic species
(3) exotic species
(4) keystone species

Manipur NEET 2023

21. Which of the following is/are cause(s) of biodiversity losses?
(1) Over-exploitation, habitat loss and fragmentation
(2) Climate change only
(3) Over-exploitation only
(4) Habitat loss and fragmentation only

2023

22. Among 'The Evil Quartet', which one is considered the most important cause driving extinction of species?
(1) Alien species invasions
(2) Co-extinctions
(3) Habitat loss and fragmentation
(4) Over exploitation for economic gain

2023

23. The historic convention on Biological Diversity, 'The Earth Summit' was held in Rio de Janeiro in the year
(1) 1986
(2) 2002
(3) 1985
(4) 1992.

2022

24. Habitat loss and fragmentation, over exploitation, alien species invasion and co-extinction are causes for
(1) population explosion
(2) competition
(3) biodiversity loss
(4) natality.

2022

25. Which of the following is not a method of ex situ conservation?
(1) In vitro fertilisation
(2) National parks
(3) Micropropagation
(4) Cryopreservation

2022

26. In-situ conservation refers to
(1) protect and conserve the whole ecosystem
(2) conserve only high risk species
(3) conserve only endangered species
(4) conserve only extinct species.

2020

27. Which of the following regions of the globe exhibits highest species diversity?
(1) Western Ghats of India
(2) Madagascar

NODIA

71. (2) detritus food chain
The detritus food chain is a specific pathway of energy flow that begins with dead organic matter, or detritus, rather than living plants. Microorganisms like bacteria and fungi act as primary consumers in this chain by breaking down the organic remains. This process is essential for releasing nutrients back into the environment, especially in ecosystems where grazing is low.

72. (3) Phytoplankton → Zooplankton → Fish
A correct food chain must accurately reflect the flow of energy from producers to successive levels of consumers. In an aquatic environment, phytoplankton are the primary producers. They are eaten by zooplankton, which serve as the primary consumers. Finally, fish act as secondary consumers by eating the zooplankton. This sequence correctly identifies the hierarchical feeding relationships in water.

73. (2) sugarcane
Sugarcane is known as one of the most efficient converters of solar energy into chemical energy among cultivated crops. It utilizes the C4 photosynthetic pathway, which allows it to minimize water loss and maintain high rates of carbon fixation even in hot, bright conditions. This results in an exceptionally high net primary productivity, making it a valuable source.

74. (3) plankton and nekton
The upper, sunlit layers of the sea, known as the euphotic zone, are inhabited by various types of organisms. Plankton are microscopic organisms like algae and small animals that drift with the currents. Nekton includes larger, actively swimming animals such as fish and squid that can move independently of the water flow. Together, they dominate the life in open ocean.

75. (3) Producers are more than primary consumers.
In most healthy and stable terrestrial ecosystems, the number and total biomass of producers significantly exceed those of the primary consumers. This occurs because energy is lost at each step of the food chain, and a large base of producers is required to sustain the levels above them. This relationship is typically illustrated by the upright shape.

76. (1) Free energy
In an ecosystem, while nutrients and elements like carbon, nitrogen, and potassium are recycled through biogeochemical cycles, the flow of energy is strictly unidirectional. Energy enters the system as sunlight and is passed through trophic levels, eventually being lost to the environment as heat. It cannot be recycled or returned to the sun during any stage.

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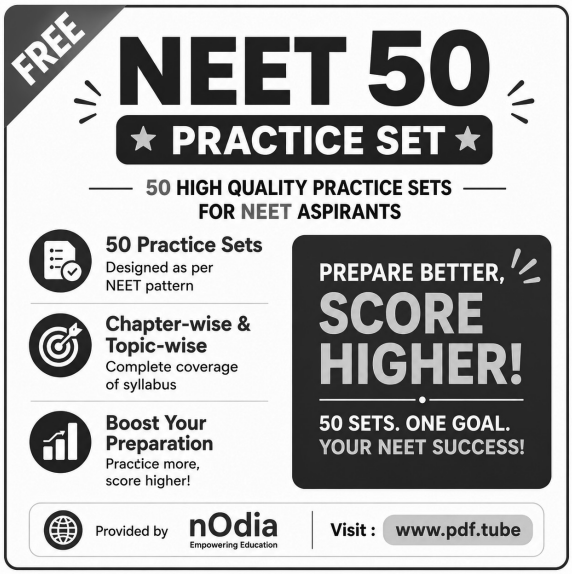

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NEET-I 2016

41. Which of the following is the most important cause of animals and plants being driven to extinction?
(1) Habitat loss and fragmentation
(2) Co-extinctions
(3) Over-exploitation
(4) Alien species invasion

NEET-II 2016

42. How many hotspots of biodiversity in the world have been identified till date by Norman Myers?
(1) 17
(2) 25
(3) 34
(4) 43

NEET-II 2016

43. Which of the following national parks is home to the famous musk deer or hangul?
(1) Keibul Lamjao National Park, Manipur
(2) Bandhavgarh National Park, Madhya Pradesh
(3) Eaglenest Wildlife Sanctuary, Arunachal Pradesh
(4) Dachigam National Park, Jammu and Kashmir

2015

44. The species confined to a particular region and not found elsewhere is termed as
(1) endemic
(2) rare
(3) keystone
(4) alien.

2015 Cancelled

45. In which of the following, both pairs have correct combination?
(1) In-situ conservation : Seed Bank
Ex-situ conservation : National Park
(2) In-situ conservation : Tissue culture
Ex-situ conservation : Sacred groves
(3) In-situ conservation : National Park
Ex-situ conservation : Botanical Garden
(4) In-situ conservation : Cryopreservation
Ex-situ conservation : Wildlife Sanctuary

2015 Cancelled

46. Cryopreservation of gametes of threatened species in viable and fertile condition can be referred to as
(1) in situ conservation by sacred groves
(2) in situ cryo-conservation of biodiversity
(3) in situ conservation of biodiversity
(4) advanced ex situ conservation of biodiversity.

2014

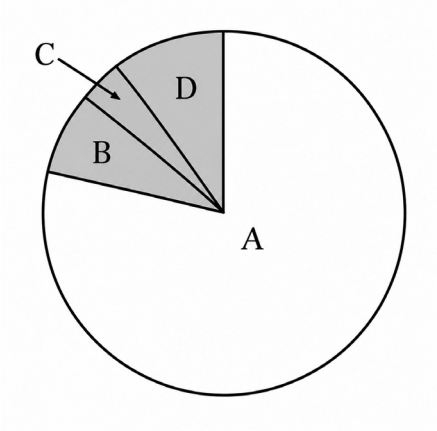
47. A species facing extremely high risk of extinction in the immediate future is called
(1) vulnerable
(2) endemic
(3) critically endangered
(4) extinct.

2014

48. The organization which publishes the Red list of species is
(1) ICFRE
(2) IUCN
(3) UNEP
(4) WWF.

2024

49. Given below is the representation of the extent of global diversity of invertebrates. What groups the four portions (A-D) represent respectively?



	A	B	C	D
(1)	Insects	Crustaceans	Other animal groups	Molluscs
(2)	Crustaceans	Insects	Molluscs	Other animal groups
(3)	Molluscs	Other animal groups	Crustaceans	Insects
(4)	Insects	Molluscs	Crustaceans	Other animal groups

2014

50. An example of ex-situ conservation is
(1) national park
(2) seed bank
(3) wildlife sanctuary
(4) sacred grove.

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(3) Himalayas
(4) Amazon forests

2020

28. According to Robert May, the global species diversity is about
(1) 1.5 million
(2) 20 million
(3) 50 million
(4) 7 million.

2019

29. Which of the following is the most important for animals and plants being driven to extinction?
(1) Alien species invasion
(2) Habitat loss and fragmentation
(3) Drought and floods
(4) Economic exploitation

Odisha NEET 2019

30. Decline in the population of indian native fishes due to introduction of Clarias gariepinus in river Yamuna can be categoriesd as
(1) co-extinction
(2) habitat fragmentation
(3) over-exploitation
(4) alien species invasion.

2019

31. The Earth Summit held in Rio de Janeiro in 1992 was called
(1) for immediate steps to discontinue use of CFCs that were damaging the ozone layer
(2) to reduce CO_2 emissions and global warming
(3) for conservation of biodiversity and sustainable utilisation of its benefits
(4) to assess threat posed to native species by invasive weed species.

2019

32. Which one of the following is not a method of in situ conservation of biodiversity ?
(1) Sacred grove
(2) Biosphere reserve
(3) Wildlife sanctuary
(4) Botanical garden

Odisha NEET 2019

33. Western Ghats have a large number of plant and animal species that are not found anywhere else. Which of the following terms will you use to notify such species?
(1) Endemic
(2) Vulnerable
(3) Threatened
(4) Keystone

2018

34. All of the following are included in 'ex-situ conservation' except
(1) wildlife safari parks
(2) sacred groves
(3) botanical gardens
(4) seed banks.

2017

35. Alexander von Humboldt described for the first time
(1) laws of limiting factor
(2) species area relationships
(3) population growth equation
(4) ecological biodiversity.

2017

36. Which one of the following is related to ex-situ conservation of threatened animals and plants?
(1) Biodiversity hotspots
(2) Amazon rainforest
(3) Himalayan region
(4) Wildlife safari parks

2017

37. The region of biosphere reserve which is legally protected and where no human activity is allowed is known as
(1) buffer zone
(2) transition zone
(3) restoration zone
(4) core zone.

NEET-II 2016

38. Which of the following is correctly matched?
(1) Aerenchyma – Opuntia
(2) Age pyramid – Biome
(3) Parthenium hysterophorus – Threat to biodiversity
(4) Stratification – Population

NEET-II 2016

39. Red list contains data or information on
(1) all economically important plants
(2) plants whose products are in international trade
(3) threatened species
(4) marine vertebrates only.

NEET-I 2016

40. Which is the national aquatic animal of India?
(1) Blue whale
(2) Sea-horse
(3) Gangetic shark
(4) River dolphin

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(ii) Predator star fish Pisaster helps in maintaining species diversity of some invertebrates.
(iii) Predators ultimately lead to the extinction of prey species.
(iv) Production of chemicals such as nicotine, strychnine by the plants are metabolic disorders.
The two correct statements are
(1) (ii) and (iii)
(2) (iii) and (iv)
(3) (i) and (iv)
(4) (i) and (ii).

Mains 2010

63. The Indian rhinoceros is a natural inhabitant of which one of the Indian states?
(1) Uttarakhand
(2) Uttar Pradesh
(3) Himachal Pradesh
(4) Assam

2010

64. Which one of the following is an example of ex-situ conservation?
(1) Wildlife sanctuary
(2) Seed bank
(3) Sacred groves
(4) National park

2009

65. Which one of the following has maximum genetic diversity in India?
(1) Mango
(2) Wheat
(3) Tea
(4) Teak

2009

66. Tiger is not a resident in which one of the following national parks?
(1) Sunderbans
(2) Gir
(3) Jim Corbett
(4) Ranthambhor

2008

67. The table gives the populations (in thousands) of ten species (A-J) in four areas (p-s) consisting of the number of habitats given within brackets against each. Study the table and answer the question which follows.
Area and No. of habitats Species, and their populations (in thousands) in the areas

Area and No. of habitats		p (11)	q (11)	r (13)	s (12)
Species, and their population (in thousand) in the areas	A.	2.3	10.2	11.3	3.2
	B.	1.2	-	0.9	10.2
	C.	0.52	0.62	0.48	11.1
	D.	6.0	-	2.4	4.8
	E.	-	1.5	1.4	0.4
	F.	3.1	3.0	4.2	3.3
	G.	1.1	-	0.8	0.8
	H.	9.0	8.2	8.4	7.3
	I.	-	1.1	2.2	11.3
	J.	10.3	11.2	4.1	2.1

Which area out of p - s shows maximum species diversity?
(1) s
(2) p
(3) q
(4) r

2008

68. Which one of the following is not observed in biodiversity hotspots?
(1) Lesser inter-specific competition
(2) Species richness
(3) Endemism
(4) Accelerated species loss

2008

69. World Summit on Sustainable Development (2002) was held in
(1) Argentina
(2) South Africa
(3) Brazil
(4) Sweden.

2007

70. Which one of the following pairs of organisms are exotic species introduced in India?
(1) Lantana camara, water hyacinth
(2) Water hyacinth, Prosopis cinereria
(3) Nile perch, Ficus religiosa
(4) Ficus religiosa, Lantana camara

2007

71. One of the endangered species of Indian medicinal plants is that of
(1) Ocimum
(2) garlic
(3) Nepenthes
(4) Podophyllum.

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2007

72. Identify the odd combination of the habitat and the particular animal concerned.
(1) Sunderbans - Bengal Tiger
(2) Periyar - Elephant
(3) Rann of Kutch - Wild Ass
(4) Dachigam National Park - Snow Leopard

2006

73. Which of the following pairs of an animal and a plant represents endangered organisms in India?
(1) Banyan and black buck
(2) Bentinckia nicobarica and red panda
(3) Tamarind and rhesus monkey
(4) Cinchona and leopard

2006

74. Which of the following is considered a hotspot of biodiversity in India?
(1) Aravalli hills
(2) Western ghats
(3) Indo-gangetic plain
(4) Eastern ghats

2006

75. Which one of the following is not included under in situ conservation?
(1) National park
(2) Sanctuary
(3) Botanical garden
(4) Biosphere reserve

2006

76. Which one of the following is the correctly matched pair of an endangered animal and a national park?
(1) Great Indian bustard : Keoladeo National Park
(2) Lion : Corbett National Park
(3) Rhinoceros : Kaziranga National Park
(4) Wild ass : Dudhwa National Park

2005

77. According to IUCN Red List, what is the status of Red Panda (Ailurus fulgens)?
(1) Critically endangered species
(2) Vulnerable species
(3) Extinct species
(4) Endangered species

2005

78. Biodiversity Act of India was passed by the Parliament in the year
(1) 1992 (2) 1996
(3) 2000 (4) 2002.

2005

79. One of the most important functions of botanical gardens is that
(1) they provide a beautiful area for recreation
(2) one can observe tropical plants there
(3) they allow ex situ conservation of germplasm
(4) they provide the natural habitat for wild life.

2004

80. In your opinion, which is the most effective way to conserve the plant diversity of an area?
(1) By tissue culture method
(2) By creating biosphere reserve
(3) By creating botanical garden
(4) By developing seed bank

2003

81. Which group of vertebrates comprises the highest number of endangered species?
(1) Mammals
(2) Fishes
(3) Reptiles
(4) Birds

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2003

82. Which endangered animal is the source of the world's finest, lightest, warmest and most expensive wool - the shahtoosh?
(1) Nilgai
(2) Cheetal
(3) Kashmiri goat
(4) Chiru

2002

83. Wildlife is continuously decreasing. What is the main reason of this?
(1) Predation
(2) Cutting down of forest
(3) Destruction of habitat
(4) Hunting

2001

84. Occurrence of endemic species in South America and Australia is due to
(1) these species has been extinct from other regions
(2) continental separation
(3) there is no terrestrial route to these places
(4) retrogressive evolution.

2000

85. Indri-indri lemur is found in
(1) Madagascar
(2) Mauritius
(3) India
(4) Sri Lanka.

2000

86. Viable material of endangered species can be preserved by
(1) gene bank
(2) gene library
(3) herbarium
(4) gene pool.

1999

87. Which of the following is mainly responsible for the extinction of wildlife?
(1) Pollution of air and water
(2) Hunting of flesh
(3) Destruction of habitats
(4) All of these

1998

88. What is the major cause of diminishing wildlife number?
(1) Felling of trees
(2) Paucity of drinking water
(3) Cannibalism
(4) Habitat destruction

1997

89. MAB stands for
(1) mammals and biosphere
(2) mammals and biology programme
(3) man and biology programme
(4) man and biosphere programme.

1996

90. The breeding place of Flamingo (Hansawar) in India is most likely
(1) Rann of Kutch
(2) Ghana Vihar
(3) Sambhar lake
(4) Chilika lake.

1995

91. The abundance of a species population, within its habitat, is called
(1) relative density
(2) regional density
(3) absolute density
(4) niche density.

1995

92. Identify the correct match between tiger reserve and its state.
(1) Manas - Assam
(2) Corbett - Madhya Pradesh
(3) Bandipur - Tamil Nadu
(4) Palamu - Odisha

1995

93. Which of the following is the matching pair of a sanctuary and its main protected wild animal?
(1) Kaziranga-Musk deer
(2) Gir-Lion
(3) Sunderban-Rhino
(4) All of these

1994

94. The most important human activity, leading to the extinction of wildlife, is
(1) pollution of air and water
(2) hunting for valuable wildlife products
(3) introduction of alien species
(4) alteration and destruction of the natural habitats.

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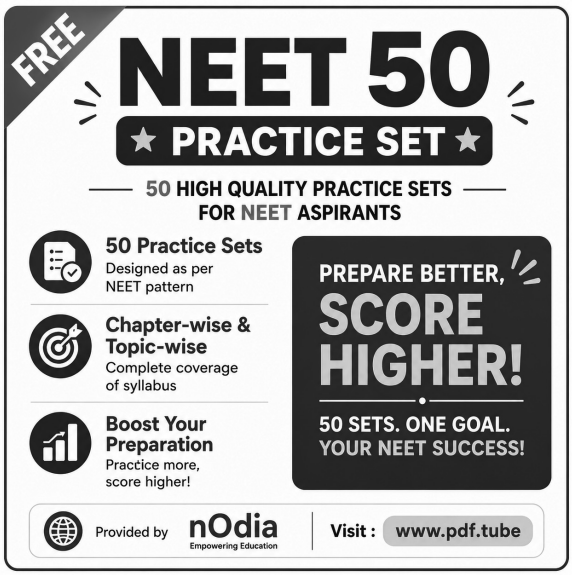

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77. (4) Endangered species
The Red Panda is classified as an endangered species according to the IUCN Red List. This status indicates that the population is facing a very high risk of extinction in the wild. Primary threats to this mammal include habitat loss, fragmentation, and poaching within its native mountain forests. International and local conservation programs are essential to protect its remaining habitat and numbers.

78. (4) 2002.
The Biological Diversity Act was passed by the Indian Parliament in 2002 to fulfill the obligations under the Convention on Biological Diversity. This legislation aims to provide for the conservation of biological resources, their sustainable use, and the fair sharing of benefits arising from them. It established national and local authorities to manage and protect the country's vast and unique biological heritage.

79. (3) they allow ex situ conservation of germplasm
Botanical gardens serve many roles, but one of their most vital functions is the ex-situ conservation of plant germplasm. By growing and maintaining rare and threatened species outside their natural habitats, these gardens act as a living repository of genetic diversity. This ensures that plant species at risk of extinction in the wild can be preserved and potentially reintroduced in the future.

80. (2) By creating biosphere reserve
Creating a biosphere reserve is a highly effective way to conserve plant diversity because it protects the entire ecosystem in its natural state. This in-situ approach safeguards not just individual species but also the ecological processes and habitats they depend on. Biosphere reserves also integrate conservation with sustainable development, ensuring that biological variety is maintained while supporting the needs of local communities.

81. (1) Mammals
Among all vertebrate groups, amphibians currently comprise the highest percentage of species that are facing the threat of extinction. Factors such as habitat destruction, poaching, and climate change have severely impacted many mammal populations worldwide. Because mammals often require large territories and have slower reproductive rates, they are particularly vulnerable to environmental pressures, leading to a higher percentage of species facing extinction compared to others.

82. (4) Chiru
The Tibetan antelope, also known as the Chiru, is the source of shahtoosh, one of the world's most expensive and fine wools. Because the animal must be killed to obtain the wool, it has become highly endangered due to illegal hunting. International trade in shahtoosh is strictly prohibited to protect the remaining populations of this unique species from total extinction in the wild.

83. (3) Destruction of habitat
The primary and most critical reason for the continuous decrease in wildlife populations is the destruction of their natural habitats. Human activities like deforestation, urbanization, and agricultural expansion remove the essential resources and space that animals need to survive. When their homes are destroyed, species cannot find food or reproduce, leading to a rapid decline in numbers and increasing the risk of extinction.

84. (2) continental separation
The presence of unique endemic species in South America and Australia is largely the result of continental separation. Millions of years ago, these landmasses drifted away from others, isolating their resident flora and fauna. This long-term geographical isolation allowed species to evolve independently, leading to the development of many distinctive organisms, such as marsupials in Australia, that are not found elsewhere.

85. (1) Madagascar
The Indri-indri is the largest living lemur and is found exclusively on the island of Madagascar. This region is famous for its high level of endemism, as many of its species evolved in isolation from mainland Africa. Protecting the remaining tropical forests of Madagascar is essential for the survival of the Indri-indri and many other unique primates that face habitat loss.

86. (1) gene bank
A gene bank is a type of biorepository that preserves genetic material from endangered species to ensure their long-term survival. This can include seeds, plant cuttings, or frozen

NODIA

11. (4) IUCN.
The International Union for Conservation of Nature is responsible for monitoring the status of various species globally. This organization maintains and publishes a comprehensive list that identifies organisms facing different levels of extinction risk. By providing detailed data on threatened plants and animals, it helps guide international conservation priorities and legal protections to ensure global biological sustainability.

12. (1) A, C, D and E only
Tropical regions exhibit high species richness because their latitudes remained relatively undisturbed for millions of years, allowing ample time for diversification. Abundant solar energy and constant, predictable environments further promote niche specialization. These stable conditions support a wide variety of life forms, unlike temperate regions where frequent glaciations in the past have historically limited the accumulation of species.

13. (2) A-III, B-I, C-IV, D-II
Global species diversity was estimated at approximately seven million by Robert May using statistical models. Alexander von Humboldt established the species-area relationship through observations in South American jungles. Paul Ehrlich proposed the rivet popper hypothesis to explain ecosystem stability. David Tilman conducted long-term experiments using outdoor plots to demonstrate how increased species diversity contributes to greater ecosystem productivity.

14. (3) biodiversity hotspots
Regions identified as biodiversity hotspots are characterized by exceptional species richness and a high degree of endemism. These areas face significant threats, having already lost at least seventy percent of their original habitat and native species. Protecting these critical zones is a priority for conservationists because they contain a large portion of the world's most vulnerable biological heritage.

15. (2) Botanical garden
In-situ conservation focuses on protecting species within their natural surroundings by preserving entire ecosystems. Examples include national parks, wildlife sanctuaries, and biosphere reserves where organisms interact naturally with their environment. In contrast, botanical gardens involve moving plants to artificial, human-managed settings. This method is classified as ex-situ conservation because the organisms are maintained outside of their original habitats.

16. (3) preservation of gametes in viable and fertile condition for a long period
Cryopreservation is an advanced technique used to store biological materials at extremely low temperatures, typically using liquid nitrogen. This method allows for the long-term preservation of gametes from threatened species in a viable and fertile state. By maintaining these cells, scientists can ensure that genetic diversity is protected even if the individual organisms face extinction in the wild.

17. (1) A-IV, B-I, C-II, D-III
Western Ghats are recognized as a major biodiversity hotspot due to high species richness and endemism. Sacred groves, such as those in the Khasi and Jaintia hills, are traditional methods of habitat protection. The 2002 World Summit on Sustainable Development took place in Johannesburg. Species like Parthenium represent alien invasions that threaten native biological diversity and local ecosystems.

18. (2) biodiversity conservation
Protecting threatened species often requires taking them out of their natural habitats and placing them in specialized settings. This approach ensures they receive the protection and care necessary for survival when their wild environments become too dangerous. Such efforts are part of a broader strategy to maintain biological variety and prevent the permanent loss of vulnerable plant and animal populations.

19. (1) species within a genus
The rivet popper hypothesis uses an airplane analogy to illustrate the importance of diversity within biological groups. In this model, every species acts as a crucial component that maintains the functional integrity of the whole system. Just as missing rivets can eventually cause a plane to fail, the loss of individual species within an ecosystem can lead to ecosystem instability.

20. (4) keystone species
Certain species play a disproportionately large role in maintaining the structure and health of their ecological community. Known as keystone

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species, they influence the relative abundance and diversity of many other organisms within the same habitat. Their presence is vital for ecosystem stability, as their removal can lead to significant and often detrimental changes in the entire biological network.

21. (1) Over-exploitation, habitat loss and fragmentation
The decline of biological diversity is primarily caused by human activities that disrupt natural environments and deplete resources. Habitat loss and the breaking up of large areas into smaller fragments prevent species from thriving. Furthermore, over-exploitation through excessive hunting or harvesting reduces populations faster than they can recover. These factors combined represent significant threats to global species survival and stability.

22. (3) Habitat loss and fragmentation
Among the four major causes of extinction, the destruction and breaking up of natural environments is considered the most significant threat. When large habitats are divided into smaller patches, many species lose the resources and space required for survival. This process particularly affects migratory animals and those needing large territories, leading to a rapid decline in population and eventual extinction.

23. (4) 1992.
The Earth Summit was a landmark international convention focused on biological diversity and environmental protection. Held in Rio de Janeiro in 1992, it brought nations together to discuss the conservation of species and the sustainable use of natural resources. This historic meeting resulted in commitments to protect the planet's biological heritage for the benefit of both present and future generations.

24. (3) biodiversity loss
The extinction of species and the decline in biological variety are driven by several critical factors. Habitat destruction, the over-use of natural resources, and the introduction of invasive alien species all contribute to this trend. Additionally, co-extinction further accelerates the problem. These interconnected issues are the primary reasons for the significant reduction in global species populations seen today.

25. (2) National parks
Ex-situ conservation involves protecting biological diversity outside of natural habitats using methods like in vitro fertilization, micropropagation, and cryopreservation. These techniques allow for the intensive management and preservation of species in controlled laboratory or artificial settings. National parks, however, represent in-situ conservation, as they aim to protect entire ecosystems and the species within them in their original wild environment.

26. (1) protect and conserve the whole ecosystem
In-situ conservation is a strategy that focuses on protecting species within their natural habitats by maintaining entire ecosystems. Instead of focusing only on individual endangered organisms, this approach preserves the complex interactions and environment necessary for all life forms to thrive. By safeguarding these areas, conservationists ensure that biological processes continue naturally without the need for moving species to artificial settings.

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27. (4) Amazon forests
The Amazon rainforests in South America represent the most biologically diverse region on the planet. These vast tropical forests are home to an incredible number of plant, bird, mammal, and invertebrate species. The consistent climate and high levels of solar energy support a complex web of life, making it a critical area for global biodiversity and environmental health.

28. (4) 7 million.
Estimates of the total number of species on Earth vary widely among scientists due to the vastness of unexplored regions. Robert May provided a more conservative and scientifically grounded global estimate of approximately seven million species. This figure accounts for the large number of undiscovered organisms, particularly in tropical regions and among groups like insects and microscopic life forms.

29. (2) Habitat loss and fragmentation
The most significant factor driving the extinction of various animals and plants is the destruction of their natural living spaces. When human activities like agriculture or urbanization fragment large forests into small pieces, the balance of the ecosystem is disrupted. Many species cannot survive in these reduced areas,

leading to population declines and the eventual loss of biological diversity.

30. (4) alien species invasion.
The introduction of non-native species can have devastating effects on local biological communities. In the river Yamuna, the presence of the African catfish, Clarias gariepinus, led to a significant decline in the population of indigenous fishes. This phenomenon is a classic example of how an invasive alien species can outcompete and prey upon native organisms, causing significant ecological damage.

31. (3) for conservation of biodiversity and sustainable utilisation of its benefits
The 1992 Earth Summit in Rio de Janeiro was organized to address the urgent need for global environmental protection. Participating nations focused on creating strategies for the conservation of biological diversity and ensuring the sustainable utilization of its benefits. This historic agreement aimed to balance economic development with the preservation of the planet's diverse life forms for future generations.

32. (4) Botanical garden
In-situ conservation aims to protect species within their natural habitats through designated areas like sacred groves, biosphere reserves, and wildlife sanctuaries. These methods allow organisms to exist and evolve in their original environments. Botanical gardens, however, are man-made facilities where plants are grown outside their natural range. Therefore, they are considered a method of ex-situ rather than in-situ conservation.

33. (1) Endemic
Species that are native to a specific geographical area and are not found naturally anywhere else in the world are described as endemic. The Western Ghats of India house a large number of such unique plant and animal species. This high level of endemism makes the region a critical priority for conservation, as these organisms are particularly vulnerable to extinction.

34. (2) sacred groves
Ex-situ conservation involves the protection of species in human-managed environments away from their natural homes, such as wildlife safari parks, botanical gardens, and seed banks. These facilities provide safety and controlled conditions. Sacred groves, however, are protected patches of forest where local communities preserve nature in its original location. This makes them a form of in-situ conservation rather than ex-situ.

35. (2) species area relationships
Alexander von Humboldt was a pioneering naturalist who observed that species richness increases with the explored area, but only up to a certain limit. This fundamental concept, known as the species-area relationship, is often represented mathematically as a rectangular hyperbola. His work in the South American jungles provided essential insights into how biological diversity is distributed across different geographical scales.

36. (4) Wildlife safari parks
Protecting threatened animals and plants outside their natural environments is known as ex-situ conservation. Wildlife safari parks are examples of this method, as they provide a controlled setting where species can be protected and monitored. In contrast, biodiversity hotspots, the Amazon rainforest, and the Himalayan region are natural areas where conservation occurs in-situ, within the organisms' original habitats.

37. (4) core zone.
A biosphere reserve is divided into different zones to balance conservation and human activity. The core zone is the innermost area which is legally protected and strictly dedicated to the preservation of biodiversity. In this region, no human interference or activity is permitted. This ensures that the natural ecosystem and its species can thrive undisturbed by any anthropogenic factors or development.

38. (3) Parthenium hysterophorus - Threat to biodiversity
The introduction of invasive species often poses a significant danger to native biological variety. Parthenium hysterophorus, commonly known as carrot grass, is a notorious weed that has spread rapidly across many regions. It outcompetes indigenous plants and alters local ecosystems, making it a major threat to biodiversity. This invasive nature can lead to the decline of native flora and associated fauna.

39. (3) threatened species
The Red List is a comprehensive inventory maintained to track the conservation status of

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biological species worldwide. It provides essential data and information regarding organisms that are at high risk of extinction, categorized as threatened. By identifying these vulnerable species, the list helps scientists and policymakers prioritize conservation efforts and implement strategies to prevent the permanent loss of global biodiversity.

40. (4) River dolphin
The Ganges River dolphin is officially recognized as the national aquatic animal of India. This unique mammal inhabits the Ganges-Brahmaputra-Meghna and Karnaphuli-Sangu river systems. It serves as a vital indicator of the health of the river ecosystem. Conservation efforts for this species are important, as it faces threats from pollution, habitat degradation, and human activities within its narrow freshwater range.

41. (1) Habitat loss and fragmentation
The primary driver leading to the extinction of various plant and animal species is the destruction and breaking up of their natural environments. When habitats are cleared for human use or divided into small, isolated patches, many organisms can no longer find enough resources or mates to survive. This process destabilizes populations and is the most significant cause of modern biodiversity decline.

42. (3) 34
Biodiversity hotspots are regions with very high levels of species richness and significant endemism that are also under constant threat. Norman Myers originally identified a smaller number of these areas, but subsequent evaluations and research have expanded the list. Currently, thirty-four such hotspots have been recognized globally. These areas are prioritized for conservation because they contain unique biological wealth.

43. (4) Dachigam National Park, Jammu and Kashmir
Dachigam National Park, located in Jammu and Kashmir, is specifically known for being the last remaining natural home of the Hangul, or Kashmir stag. This endangered subspecies of red deer is closely related to the musk deer in terms of regional conservation focus. Protecting this high-altitude habitat is essential for the survival of this unique animal, which faces various environmental pressures.

44. (1) endemic
When a species is restricted to a specific geographical location and does not occur naturally in any other part of the world, it is classified as endemic. Such organisms are often found on islands or in isolated mountain ranges and unique ecosystems. Because their range is so limited, endemic species are particularly vulnerable to habitat destruction and other environmental changes.

45. (3) In-situ conservation : National Park Ex-situ conservation : Botanical Garden
Conservation strategies are divided into in-situ and ex-situ methods. In-situ conservation, such as the establishment of national parks, protects species within their natural habitats. Ex-situ conservation involves maintaining organisms outside their original environments, as seen in botanical gardens or seed banks. Matching these correctly is essential for understanding how different approaches are used together to preserve global biological diversity effectively.

NODIA

46. (4) advanced ex situ conservation of biodiversity.
Storing gametes of threatened species at extremely low temperatures ensures they remain viable and fertile for long periods. This technique, known as cryopreservation, is considered an advanced form of ex-situ conservation because it takes place in a highly controlled laboratory environment far from the natural habitat. It provides a modern scientific backup to prevent the total loss of genetic information.

47. (3) critically endangered
The conservation status of a species is determined by the level of risk it faces in the wild. An organism that is categorized as critically endangered is at an extremely high risk of becoming extinct in the very near future. This classification signals an urgent need for intensive conservation measures and immediate intervention to prevent the species from disappearing forever.

48. (2) IUCN
The International Union for Conservation of Nature is a global authority that assesses the status of the natural world. It publishes the Red List of Threatened Species, which provides critical information on the extinction risk of

thousands of organisms. This data is essential for international cooperation, helping to direct funding and protection efforts toward the species that need them most.

49. (4) Insects Molluscs Crustaceans Other animal groups
Invertebrate diversity on a global scale is dominated by insects, which comprise the vast majority of known animal species. Other animal groups also represent a significant portion of the total invertebrate population, followed by molluscs and crustaceans, illustrating the immense variety and biological complexity found within the world's invertebrate fauna.

50. (2) seed bank
Ex-situ conservation involves preserving biological components outside their natural surroundings. A seed bank is a perfect example, as it stores seeds of various plant species in controlled conditions to ensure their long-term survival. In contrast, national parks, wildlife sanctuaries, and sacred groves are all forms of in-situ conservation, where species are protected within their original, natural ecological settings.

51. (1) Fungi
Fungi represent a massive portion of global species diversity, with more species recorded than all fishes, amphibians, reptiles, and mammals combined. These organisms play vital roles as decomposers and symbionts in various ecosystems. Their immense variety and numbers far exceed those of other groups like mosses, ferns, algae, or lichens, making them a dominant group in terms of species richness.

52. (4) Rice
India is a major center of diversity for many important crop plants. Rice exhibits an extraordinary level of genetic variety within the country, with over fifty thousand different strains identified. This immense genetic diversity is a result of thousands of years of cultivation and adaptation to diverse climatic and soil conditions across various regions, making it an invaluable biological resource.

53. (1) IUCN
The Red Data Book is a vital document that lists the conservation status of various species of plants and animals. It is published by the International Union for Conservation of Nature. By documenting which species are endangered, vulnerable, or rare, it provides a scientific basis for environmental policies and conservation actions aimed at protecting the world's diverse biological heritage.

54. (1) Shifting cultivation
Ex-situ conservation involves techniques like botanical gardens, field gene banks, and seed banks, which preserve plant species outside their natural environments. These methods are designed to protect genetic diversity in controlled settings. Shifting cultivation, however, is a traditional agricultural practice involving the clearing and burning of forest patches. It is not a conservation method and often leads to habitat destruction.

55. (2) Nagarjunasagar-Srisailam
The Nagarjunasagar-Srisailam Tiger Reserve is the largest protected area for tigers in India by total area. Spanning across multiple districts in the states of Andhra Pradesh and Telangana, it encompasses diverse landscapes including forests and plateaus. This vast reserve provides a critical habitat for the Bengal tiger and numerous other wildlife species, playing a central role in national conservation efforts.

56. (4) Western Ghats
The Western Ghats mountain range along the western coast of India is recognized globally as a major biodiversity hotspot. This region is famous for its exceptionally high levels of species richness and endemism, meaning many plants and animals found here exist nowhere else. Due to significant environmental pressure and habitat loss, it is prioritized for intensive conservation to protect its unique life.

57. (3) Western ghats have a very high degree of species richness and endemism.
Biodiversity is not distributed uniformly across the globe. Certain areas, like the Western Ghats of India, contain a disproportionately high number of unique species that are not found in any other location. This high degree of richness and endemism makes such regions vital for conservation. Protecting these areas is essential for maintaining the overall biological health and variety of the planet.

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58. (2) Insects
Among all known organisms on Earth, insects are the most species-rich group in nature. They account for more than seventy percent of all animal species, reflecting their incredible evolutionary success and ability to adapt to diverse environments. This vast number of insect species far outweighs that of other groups such as fungi, birds, or angiosperms, making them ecologically dominant globally.

59. (2) the diversity in the organisms living in the region
Biodiversity refers to the variety of life forms found within a specific geographical area. It encompasses diversity at multiple levels, including genetic variation within species, the number of different species, and the complexity of entire ecosystems. Measuring this diversity helps scientists understand the health and stability of the environment and is essential for planning effective conservation strategies in that region.

60. (4) conserving rare and threatened species.
Sacred groves are small patches of forest traditionally protected by local communities due to religious beliefs. These areas often serve as last refuges for many rare, endangered, and threatened plant and animal species that have disappeared from the surrounding landscape. By preventing human interference, these groves help maintain local biodiversity and provide a natural sanctuary for various vulnerable organisms.

61. (4) (1) - hibernation, (2) - escape, (3) - expanding (5) - hotspot
Animals like bears undergo hibernation during winter to escape harsh cold weather. In human populations, a broad-based age pyramid indicates an expanding population. Furthermore, geographical areas characterized by exceptionally high levels of species richness and endemism are formally identified as biodiversity hotspots. Understanding these ecological terms is essential for describing population dynamics and prioritizing regions for global environmental conservation efforts.

62. (4) (i) and (ii).
In an ecological sense, both lions and sparrows are consumers because they derive energy by feeding on other organisms. Predation also plays a vital role in maintaining community structure; for example, the starfish Pisaster helps preserve invertebrate diversity by controlling the populations of dominant competitors. These interactions prevent any single species from monopolizing resources, thereby supporting a more diverse ecosystem.

63. (4) Assam
The Indian rhinoceros, also known as the greater one-horned rhino, is primarily found in the northeastern state of Assam. National parks like Kaziranga and Manas provide the specialized wetland and grassland habitats necessary for this species to thrive. Significant conservation efforts in this state have been successful in protecting and increasing the population of these iconic and endangered large mammals.

64. (2) Seed bank
Ex-situ conservation refers to the preservation of biological components away from their natural environments. A seed bank is a classic example where seeds are kept in controlled storage for long-term use. Wildlife sanctuaries, national parks, and sacred groves are all in-situ methods, as they focus on protecting species within the natural ecosystems where they already live and interact with nature.

65. (1) Mango
India is well-known for its vast genetic diversity in many cultivated fruits and crops. Mangoes, in particular, show a significant degree of variation across the country, with over a thousand different varieties existing. This genetic wealth is reflected in the wide range of flavors, sizes, and shapes of the fruit found in different regions, highlighting India's rich agricultural biological heritage.

66. (2) Gir
The Gir National Park in Gujarat is famous for being the last remaining natural habitat of the Asiatic lion. While other national parks like Sunderbans, Jim Corbett, and Ranthambore are well-known tiger habitats, tigers are not found in Gir. This highlights the importance of specific protected areas for conserving unique species that may have restricted ranges within the country.

67. (2) p
Species diversity is measured by both the number of different species present and the evenness of their population distribution. In the provided

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data, area p exhibits a high level of richness across its habitats. When comparing the species counts and their relative populations, this area shows the most balanced and diverse biological community among the four options, indicating higher ecological stability.

68. (1) Lesser inter-specific competition
Biodiversity hotspots are characterized by extreme species richness and a high degree of endemism. Because many different species occupy these regions, inter-specific competition for resources is typically quite intense rather than reduced. These areas also suffer from accelerated species loss due to habitat destruction. Lesser competition is not a feature of these densely populated and biologically complex ecological zones at all.

69. (2) South Africa.
The World Summit on Sustainable Development was a major international conference held in 2002. It took place in Johannesburg, South Africa, and focused on global challenges related to the environment and economic development. The summit aimed to reaffirm international commitment to sustainable practices and the conservation of biological resources, building upon the goals established a decade earlier during the Earth Summit.

70. (1) Lantana camara, water hyacinth
Exotic or alien species are those introduced to a region from outside their natural range. In India, Lantana camara and water hyacinth are well-known examples of such introductions. These species often become invasive, spreading rapidly and outcompeting native flora. Their presence disrupts local ecosystems, reduces indigenous biodiversity, and can cause significant environmental and economic problems in the areas they colonize.

71. (4) Podophyllum.
Several Indian medicinal plants are now considered endangered due to over-harvesting and habitat loss. Podophyllum, also known as the Himalayan Mayapple, is one such species that is at risk. It is valued for its medicinal properties, particularly in treating various ailments. Conservation of these plants is essential to ensure that their therapeutic benefits and genetic diversity are not lost to future generations.

72. (4) Dachigam National Park - Snow Leopard
Each national park is typically associated with a specific iconic species. While Sunderbans is famous for Bengal Tigers and Periyar for Elephants, Dachigam National Park in Jammu and Kashmir is the primary habitat for the Hangul or Kashmir stag. The snow leopard is usually found in higher altitude regions like Hemis National Park, making the combination of Dachigam and snow leopard incorrect.

73. (2) Bentinckia nicobarica and red panda
Both Bentinckia nicobarica, a species of palm tree, and the red panda are recognized as endangered organisms in India. These species face significant threats from habitat loss and environmental changes. Bentinckia nicobarica is native to the Nicobar Islands, while the red panda inhabits the high-altitude forests of the Himalayas. Protecting both is crucial for maintaining the country's unique biological and genetic diversity.

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74. (2) Western ghats
The Western Ghats are a major biodiversity hotspot in India, known for their exceptional richness in plant and animal life. This region contains many species that are endemic, meaning they are found nowhere else on the planet. Because of its ecological importance and the high level of threat it faces from human activity, it is a primary focus for conservation efforts.

75. (3) Botanical garden
In-situ conservation focuses on protecting species within their natural environments. National parks, sanctuaries, and biosphere reserves are all examples of this approach, as they safeguard entire ecosystems. A botanical garden, however, is a man-made facility where plants are grown and maintained away from their original habitats. Therefore, it is classified as an ex-situ conservation method rather than an in-situ one.

76. (3) Rhinoceros : Kaziranga National Park
Kaziranga National Park in Assam is world-renowned for its successful conservation of the endangered greater one-horned rhinoceros. This park holds the largest population of these rhinos globally. Other pairings, like lions in Corbett or wild asses in Dudhwa, are incorrect because Corbett is a tiger reserve and the Indian wild ass is found in the Rann of Kutch, not Dudhwa.

ANSWERS

1. (3) Both A and R are correct and R is the correct explanation of A
The Abingdon tortoise became extinct soon after goats were introduced. Goats, being more efficient grazers, outcompeted the tortoise for food. This competition (R) correctly explains the extinction (A), so both are correct and R explains A.

2. (4) (d) > (a) > (c) > (b) > (e)
In the Amazonian rainforest, invertebrates have the greatest species richness, followed by plants, fishes, birds, and finally mammals with the fewest. This descending order corresponds to invertebrates, plants, fishes, birds, mammals.

3. (3) Bioprospecting
Bioprospecting is the systematic exploration of biodiversity at molecular, genetic, and species levels to discover commercially valuable products such as drugs, enzymes, and chemicals. Biofortification improves nutrient content of crops, bioremediation uses microbes to clean pollutants, and biomagnification is accumulation of toxins in food chains.

4. (3) The present species extinction rates are 100 to 1000 times faster than in the pre-human times.
The current sixth extinction is driven mainly by human activities. Estimates indicate that present species extinction rates are 100 to 1000 times faster than the pre-human (background) rates. If this continues, nearly half of all species may be wiped out within the next century.

5. (2) A, B and D only
Amazon clearing for soyabean is habitat loss (A correct). Steller's sea cow and passenger pigeon vanished by over-exploitation (B correct). Water hyacinth is invasive (D correct). Nile perch caused extinction of cichlids, not growth (C wrong). Extinction affects associated species through co-extinction (E wrong).

6. (1) Sacred Groves
In situ conservation protects species in their natural habitats. Sacred groves are forest patches protected by local communities for religious reasons, conserving biodiversity on site. Safari parks, botanical gardens and seed banks are ex situ methods, where organisms are conserved outside their natural surroundings.

7. (3) Habitat loss and fragmentation; Over-exploitation; Alien species invasions; Co-extinctions
The "Evil Quartet" describes the four major causes of biodiversity loss: habitat loss and fragmentation, over-exploitation, alien species invasions, and co-extinctions. Pollution of air, water and soil are not part of this particular quartet, so only option (3) correctly lists all four causes.

8. (1) Zoos and botanical gardens
Ex-situ conservation involves the protection of endangered species outside their natural habitats. This is achieved by relocating them to controlled environments such as zoos or botanical gardens. These facilities provide specialized care, safety from predators, and managed breeding programs to increase population numbers. Such efforts are crucial for species that cannot survive in the wild currently.

9. (4) A-III, B-I, C-II, D-IV
Biodiversity loss is driven by factors known as the Evil Quartet, which include alien species invasions. Ex-situ methods like cryopreservation help preserve genetic material under extremely cold conditions for future use. Invasive plants like Lantana camara negatively impact native ecosystems. The extinction of the Dodo serves as a historical reminder of how species can vanish completely from earth.

10. (4) A, B and D only
Biological diversity is severely impacted by several major factors that lead to the permanent loss of species. Over-exploitation of natural resources and the destruction or fragmentation of habitats are primary drivers of this decline. Additionally, co-extinction occurs when the loss of one species leads to the disappearance of another dependent organism, further destabilizing various ecological communities.

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gametes and embryos. By maintaining this viable material in controlled environments, scientists can protect the genetic diversity of species that are at risk of disappearing from their natural habitats due to environmental threats.

87. (3) Destruction of habitats
While pollution and hunting significantly affect wildlife, the destruction of natural habitats is the single most important factor responsible for species extinction. When forests are cleared and wetlands are drained, the entire ecosystem that supports various life forms is lost. Without a suitable place to live, feed, and breed, populations inevitably collapse, leading to the permanent disappearance of numerous biological species.

88. (4) Habitat destruction
The major cause of the diminishing numbers of wildlife globally is the destruction of their natural environments. As human populations expand, wild areas are converted for agriculture, industry, and housing. This loss of living space deprives animals of their food sources and breeding grounds. Habitat destruction is far more impactful than other factors like cannibalism or water scarcity in driving species toward extinction.

89. (4) man and biosphere programme.
MAB stands for the Man and Biosphere Programme, which was launched by UNESCO to promote a balanced relationship between people and their environment. This international initiative focuses on the conservation of biodiversity and the sustainable use of natural resources. It established a global network of biosphere reserves where research and conservation efforts are integrated with the needs of local human populations.

90. (1) Rann of Kutch
The Rann of Kutch in Gujarat is a significant breeding ground for the Greater Flamingo in India. This vast salt marsh provides the unique environmental conditions, including shallow water and isolated mudflats, that these birds require for nesting and raising their young. Thousands of flamingos migrate to this region annually, making it a critical habitat for the conservation of this iconic avian species.

91. (4) niche density.
The abundance of a species population within its specific habitat or functional role is referred to as niche density. It measures how many individuals of a species exist in a particular area where they can successfully interact with their environment and other organisms. Understanding niche density helps ecologists assess the health of a population and its impact on the surrounding biological community.

92. (1) Manas - Assam
Manas National Park is a major tiger reserve located in the state of Assam and is also a UNESCO World Heritage site. It provides a vital habitat for various endangered species beyond just tigers. Other pairings like Corbett in Madhya Pradesh are incorrect because Corbett is in Uttarakhand, and Bandipur is in Karnataka, while Palamu is located in the state of Jharkhand.

93. (2) Gir-Lion
Gir National Park in Gujarat is the only natural habitat where Asiatic lions are protected and found today. This makes it a perfect matching pair of a sanctuary and its main protected animal. Other options are incorrect as Kaziranga is famous for rhinoceros rather than musk deer, and the Sunderbans is primarily a tiger reserve rather than being known specifically for rhinos.

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94. (4) alteration and destruction of the natural habitats.
The most significant human activity contributing to the extinction of wildlife is the alteration and destruction of natural habitats. By changing the landscape through deforestation, pollution, and construction, humans remove the essential conditions required for species to survive. This loss of habitat disrupts ecological balances and is the primary driver behind the rapid decline of global biodiversity and the loss of species.

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